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CIS

ACID RAIN

HEARINGS

BEFORE THE

SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT

OF THE

COMMITTEE ON SCIENCE AND TECHNOLOGY U.S. HOUSE OF REPRESENTATIVES

NINETY-SEVENTH CONGRESS

FIRST SESSION

SEPTEMBER 18, 19; NOVEMBER 19; DECEMBER 9, 1981

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ACID RAIN

FRIDAY, SEPTEMBER 18, 1981

House of Representatives,
Committee on Science and Technology,
Subcommittee on Natural Resources,
Agriculture Research and Environment,
Washington, D.C.

The subcommittee met, pursuant to call, at 9:25 a.m., at the Olympic Center, Lussi Convention Hall, Main Street, Lake Placid, N.Y., Hon. James H. Scheuer (chairman of the subcommittee) presiding.

Mr. Scheuer. This hearing of the Subcommittee on Natural Resources, Agriculture Research and Environment will come to order.

This hearing is the second hearing in a series we are having on the problems of acid rain, both as they affect the United States and Canada.

We have met with Canadian parliamentarians, as well as with parliamentarians and environmental officials in England, France, and Germany.

There is scarcely a global problem of more serious dimensions than the problem of acid rain. The importance to our Members of Congress is evidenced by the fact that at the end of a very hectic and busy session of Congress, we have seven Members of Congress in attendance for this hearing and eager to participate.

Tomorrow we will be meeting with a number of members of the Canadian Parliament and members of their environment ministry.

Today, at this hearing, we will be hearing from experts on the problem of the generation of pollution, the transportation of the polluting elements and the impact of environmental rain in its final form as it affects cropland, rivers, lakes, forest growth and, of course, man-made buildings and the health of the American people.

[The opening statement of Mr. Scheuer follows:]

OPENING STATEMENT

HONORABLE JAMES H. SCHEUER

SEPTEMBER 18, 1981

THIS HEARING OF THE SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT WILL COME TO ORDER.

TODAY'S HEARING AND TOMORROW'S BRIEFING ON THE IMPACT OF ACID PRECIPITATION ON NEW YORK AND ON CANADA IS PART OF A CONTINUING EFFORT BY THIS SUBCOMMITTEE TO EXAMINE THE PROBLEMS ASSOCIATED WITH ACID RAIN.

TODAY WE WILL HEAR EXPERT WITNESSES TESTIFY ON STATE AND FEDERAL PRESENT AND FUTURE EFFORTS TO STUDY AND RESOLVE THE ISSUE.

WE WILL ALSO HEAR SCIENTISTS PRESENT THE RECENT RESEARCH RESULTS ON THE FORMATION, TRANSPORTATION, AND ENVIRONMENTAL IMPACT OF ACID RAIN.

FINALLY WE WILL HEAR PANELS OF WITNESSES COMPOSED OF CITIZENS FROM THE REGION DISCUSS THE IMPACT OF ACID RAIN ON SPECIFIC ASPECTS OF HEALTH AND WELFARE.

THIS NATURAL RESOURCES SUBCOMMITTEE HAS HELD FOUR PREVIOUS HEARINGS THIS YEAR ON THE IMPACT OF AIR POLLUTION ON THE ENVIRONMENT AND MUCH OF THE TESTIMONY RECEIVED WAS DIRECTED TOWARD ACID PRECIPITATION.

IT IS PARTICULARLY APPROPRIATE THAT WE ADDRESS THIS ISSUE IN THE ADIRONDACKS.

THIS REGION REPRESENTS ONE OF THE LARGEST LAKE DISTRICTS SENSITIVE TO ACID RAIN AND AS A RESULT IT IS HEAVILY DAMAGED.

A 1981 LIBRARY OF CONGRESS REPORT INDICATED THAT AS MANY AS 200 LAKES IN THIS REGION ARE DEVOID OF FISH.

ENTIRE FISH COMMUNITIES CONSISTING OF BROOK TROUT, LAKE TROUT, PRAWN BULLHEAD, AND OTHERS HAVE BEEN ELIMINATED OVER THE PERIOD OF YEARS AS THE LEVELS OF ACIDITY HAVE INCREASED.

THERE IS EVIDENCE THAT BUILDINGS, MONUMENTS, PAINTS, AND OTHER BUILDING MATERIALS ARE NOT IMMUNE TO THE EFFECTS OF ACID RAIN.

THE COUNCIL ON ENVIRONMENTAL QUALITY HAS ESTIMATED DAMAGE, ON A NATIONWIDE BASIS, TO THESE MATERIALS TO BE $1 BILLION ANNUALLY.

ACID PRECIPITATION IS ALSO LINKED TO MAJOR DAMAGE OF VARIOUS AGRICULTURAL CROPS.

ONE STUDY HAS ESTIMATED AGRICULTURAL DAMAGE TO BE APPROXIMATELY $1 BILLION ANNUALLY.

THE POSSIBILITIES THAT ACID RAIN MAY CAUSE FOREST GROWTH REDUCTIONS ARE ALSO VERY REAL CONCERNS BOTH IN THE ADIRONDACKS AND IN CANADA.

TESTIMONY GIVEN BEFORE THIS SUBCOMMITTEE IN MAY STATED THAT ACID DEPOSITION IS MORE HARMFUL BOTH DIRECTLY AND INDIRECTLY TO HUMAN HEALTH THAN WAS PREVIOUSLY BELIEVED.

THE DIRECT EFFECTS RESULT FROM INHALATION OF PARTICULATE AND ACIDIC COMPONENTS OF ACID DEPOSITION ALONE OR IN COMBINATION WITH OTHER AIR POLLUTANTS.

THE IMPACT IS PARTICULARLY HARMFUL TO THE ELDERLY, THE VERY YOUNG, AND TO THOSE WHO SUFFER FROM

RESPIRATORY AILMENTS.

INDIRECT EFFECTS RESULT FROM THE CORROSIBILITY OF HIGH ACIDITY PRECIPITATION WHICH MAY DISSOLVE TOXIC METALS FROM SOILS AND ROCKS AND FROM PLUMBING IN DRINKING WATER DISTRIBUTION SYSTEMS.

INDEED, STUDIES HAVE SHOWN THAT WATER SUPPLIES IN THE HINCKLEY RESERVOIR IN NEW YORK STATE ARE CONTAMINATED BY A CONCENTRATION OF LEAD ABOVE SAFE LEVELS.

THE LEAD WAS REPORTED TO HAVE BEEN LEACHED FROM PIPES BY ACID WATER.

THE MAGNITUDE OF LOSSES TO PUBLIC HEALTH AND TO THE ENVIRONMENT FROM ACID PRECIPITATION ARE JUST NOW BEGINNING TO BE UNDERSTOOD.

A NATIONAL ACADEMY OF SCIENCES STUDY PLACED THE DAMAGE AT SOME FIVE

BILLION DOLLARS PER YEAR, WITH DESTRUCTION INCREASING DAILY.

TODAY'S WITNESSES MAY DISAGREE ON SOME SPECIFIC FACTS, BUT I AM SURE NONE WILL DISAGREE WITH THE FACT THAT ACID RAIN IS A SIGNIFICANT PROBLEM AND THAT IT MUST BE BROUGHT UNDER CONTROL AS SOON AS POSSIBLE.

BECAUSE OF THE NUMBER OF WITNESSES THAT WE HAVE TODAY, IT IS NECESSARY FOR ME TO REQUEST THAT EACH PANEL WITNESS LIMIT THEIR REMARKS TO NO MORE THAN FIVE MINUTES.

OF COURSE, THE FULL TEXT OF THEIR PREPARED TESTIMONY WILL BE INCLUDED IN THE HEARING RECORD.

I WOULD LIKE TO WELCOME MY FELLOW CONGRESSMEN AND SAY THAT I LOOK FORWARD TO YOUR ACTIVE PARTICIPATION

IN THIS HEARING.

I NOW RECOGNIZE CONGRESSMAN WILLIAM CARNEY OF NEW YORK, WHO IS RANKING MINORITY MEMBER OF THIS SUBCOMMITTEE, FOR ANY STATEMENT HE MAY WISH TO MAKE.

- -

OUR FIRST WITNESS WILL BE THE DISTINGUISHED SPEAKER OF THE NEW YORK STATE ASSEMBLY, STANLEY FINK.

SPEAKER FINK HAS PLAYED A PROMINENT ROLE IN NEW YORK'S EFFORTS TO DEAL WITH THE PROBLEM OF ACID RAIN AND IT WAS AT HIS SUGGESTION THAT WE CHOSE THE ADIRONDACKS FOR THIS HEARING.

MR. SPEAKER, AS YOU CAN SEE FROM THE NUMBER OF MEMBERS THAT WE HAVE WITH US TODAY IT WAS AN EXCELLENT SUGGESTION.

I WOULD LIKE TO THANK YOU AND YOUR STAFF FOR THE TREMENDOUS AMOUNT OF ASSISTANCE GIVEN OUR SUBCOMMITTEE IN PREPARING FOR THIS HEARING.

WE ARE PLEASED TO HAVE YOU WITH US, SPEAKER FINK.

Mr. **Scheuer**. We are very happy to welcome as our first speaker, Assemblyman Stanley Fink, the Speaker of the New York State Assembly. I wish to thank him and members of his staff who have been so helpful in putting this hearing together.

Speaker Fink has played a key role in New York State and in the Nation in facing up to the challenging problems of acid rain and its effect on the environment. We are very happy to welcome him as our first speaker.

Before I introduce Speaker Fink, I would like to recognize the ranking minority member of this committee, the very hard working and tremendously contributing member of our committee, Congressman Bill Carney of New York.

Mr. **Carney**. Thank you, Mr. Chairman.

I would ask permission to revise and extend my remarks and submit them in the record as an opening statement.

[The opening statement of Mr. Carney follows:]

OPENING STATEMENT BY CONGRESSMAN WILLIAM CARNEY
RANKING MINORITY MEMBER
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURAL RESEARCH AND ENVIRONMENT
HEARING ON ACID PRECIPITATION
LAKE PLACID, NEW YORK
SEPTEMBER 18, 1981

MR. CHAIRMAN, ACID RAIN HAS BEEN CALLED EVERYTHING FROM A TIME BOMB FOR THE 1980S TO AN ESCALATING ENVIRONMENTAL PROBLEM OF BOTH NATIONAL AND INTERNATIONAL DIMENSIONS. THERE ARE ALSO THOSE WHO SAY THAT THE PROBLEM HAS BEEN OVERRATED AND THAT THE OBSERVED DAMAGE TO PLANTS AND WILDLIFE IS DUE, AT LEAST IN PART, TO OTHER SOURCES.

CLEARLY, WHILE A CONSENSUS MAY NOT EXIST ON THE MAGNITUDE OF THE PROBLEM OR THE BEST WAY TO SOLVE IT, THERE CAN BE LITTLE QUESTION, AS YOU YOURSELF IMPLIED, THAT A PROBLEM EXISTS AND THAT SOLUTIONS MUST BE FOUND. THESE SOLUTIONS WILL LIKELY INCLUDE ADMINISTRATIVE, LEGISLATIVE AND JUDICIAL ACTIONS. ACHIEVING THESE SOLUTIONS WILL BE DIFFICULT BECAUSE ACID RAIN IS A COMPLEX PROBLEM THAT IS NOT FULLY UNDERSTOOD.

FOR THESE REASONS, MR. CHAIRMAN, I BELIEVE YOU ARE TO BE COMMENDED FOR HAVING SELECTED THIS SUBJECT AS ONE TO COVER AT A SUBCOMMITTEE FIELD HEARING. THERE ARE MANY DEMANDS ON OUR TIME, AND NUMEROUS PRESSING ISSUES FOR US TO ADDRESS, SO THE SELECTION OF ACID RAIN AS A HEARING TOPIC SHOWS THE HIGH IMPORTANCE YOU ATTACH TO THIS MATTER. I FULLY SUPPORT YOUR DECISION.

I ALSO CONCUR IN YOUR CHOICE OF LAKE PLACID AS THE HEARING LOCATION, AS I DON'T BELIEVE THERE IS A MORE APPROPRIATE PLACE IN THIS PART OF THE COUNTRY FOR US TO ADDRESS THE ACID RAIN ISSUE. WHILE THERE MAY BE SOME DISAGREEMENT OVER THE NATURE OF THE PROBLEM AND THE BEST SOLUTIONS, AS I MENTIONED A MOMENT AGO, IT IS ENTIRELY CLEAR THAT THE ACIDITY MEASUREMENTS FROM LAKES IN THE ADIRONDACK PARK AREA OF NEW YORK HAVE GONE FROM AN AVERAGE pH OF ABOUT 6.8 IN THE 1930S TO ABOUT 4.8 IN 1975. THIS TREND APPEARS TO BE THE CAUSE OF THE DISAPPEARANCE OF THE ENTIRE FISH POPULATIONS FROM THE 200 LAKES THAT YOU REFERRED TO, AND FOR DECLINING FISH CATCHES AS FAR AWAY AS NEW HAMPSHIRE AND WISCONSIN. THE RAIN FALLING ON THIS AREA IS SOMETIMES 40 TIMES AS ACIDIC AS IT SHOULD BE.

IN ONTARIO, CANADA, THERE ARE 140 LAKES THAT ARE CONSIDERED DEAD BECAUSE OF ACID RAIN, AND IT IS BELIEVED THAT ONE HALF OF THE ACIDITY IN EASTERN CANADA ORIGINATES IN THE U.S. THE LONG DISTANCE TRANSPORT IN THE ATMOSPHERE OF INDUSTRIAL POLLUTANTS ACROSS GEOGRAPHICAL AND POLITICAL BOUNDARIES CAUSES NUMEROUS PROBLEMS AND HAS BECOME A SORE POINT IN OUR INTERNATIONAL RELATIONS. LIKE THE GREENHOUSE EFFECT, ACID RAIN IS KNOWN TO BE THERE, BUT ITS SOURCE IS OFTEN DIFFICULT TO PINPOINT.

EQUALLY DISTRUBING IS THE PROSPECT, ACCORDING TO SOME REPORTS, THAT THE WORST EFFECTS OF ACID RAIN ARE NOT LIKELY TO BE FELT ON LAKES AND FORESTS, OR EVEN ON CROPS, BUT ON BUILDING SURFACES AND HUMAN HEALTH. ALTHOUGH THESE EFFECTS

MAY NOT BE NECESSARILY NOTICEABLE AND WILL BE DRAWN OUT OVER A GRADUAL PERIOD OF TIME, THE IMPACT COULD BE SUBSTANTIAL WHEN ASSESSING THE HIDDEN COSTS TO THE NATIONAL ECONOMY OF MORE FREQUENT BUILDING REPAIRS AND MOUNTING HEALTH CARE COSTS.

WITH THESE IMPACTS IN MIND, THERE ARE A NUMBER OF ADDITIONAL THINGS THAT I WOULD LIKE TO KNOW ABOUT ACID RAIN, AND SEVERAL QUESTIONS WHICH I HOPE OUR WITNESSES WILL ADDRESS AT TODAY'S HEARING. THEY ARE:

(1) IS THE ACIDITY OF PRECIPITATION CHANGING? SOME DATA GATHERED IN THE EASTERN U.S. INDICATES THAT THERE HAS BEEN AN INCREASE, BUT SOME SCIENTISTS DISPUTE THE FINDING.

(2) WHAT IS THE CONNECTION BETWEEN ACID RAIN AND EMISSIONS OF SULPHUR OXIDES AND NITROGEN OXIDES? WHICH OF THE TWO IS THE MAJOR CONTRIBUTOR, AND WHAT ARE ITS SOURCES?

(3) WHAT IS THE COST OF DAMAGE FROM ACID PRECIPITATION? IN ONE STATE ALONE, THE DAMAGE TO FRESHWATER FISHERIES HAS BEEN ESTIMATED AT $46 MILLION. ON A NATIONAL BASIS, CONSIDERING CROP DAMAGE, FORESTRY DAMAGE, ETC., THE COST EASILY RUNS INTO BILLIONS OF DOLLARS,

(4) CAN ACID RAIN PRECIPITATION DAMAGE BE REVERSED? WHILE SOME SIGNS POINT TO AN AFFIRMATIVE ANSWER, TOO LITTLE IS KNOWN TO PROVIDE CONFIDENCE THAT THE PHENOMENON IS REVERSIBLE.

(5) HOW IS HUMAN HEALTH AFFECTED BY ACID PRECIPITATION? BOTH LUNG PROBLEMS AND BIOACCUMULATION OF HEAVY METALS IN THE FOOD CHAIN ARE POTENTIAL SOURCES OF DAMAGE.

(6) HOW CAN ACID PRECIPITATION BE PREVENTED? ALTHOUGH THE PRIMARY SOURCE OF SULPHUR AND NITROGEN OXIDES SEEMS TO BE ELECTRIC POWER PLANTS, THIS ASSUMPTION IS CHALLENGED BY THE UTILITY INDUSTRY. NEVERTHELESS, MEANS TO REDUCE THE EMISSION OF GASES APPEAR WARRANTED.

MOST OF THESE QUESTIONS WILL REQUIRE ADDITIONAL RESEARCH AND DEVELOPMENT BEFORE THEY CAN BE SATISFACTORILY ANSWERED, BUT I SUBMIT, MR. CHAIRMAN, THAT WE DO NOT HAVE THE TIME TO WAIT FOR THE RESULTS OF R&D PROGRAMS. SOME ACTIONS MUST BE TAKEN NOW TO CUT OUR LOSSES AND LIMIT FUTURE DAMAGE. AGAIN, I LOOK TO OUR DISTINGUISHED WITNESSES TO IDENTIFY WHAT COURSE WE SHOULD FOLLOW.

ONE FINAL POINT THAT SHOULD BE MADE IS "WHERE DO WE GO FROM HERE?", NOW THAT OUR SUBCOMMITTEE HAS TAKEN ITS TIME, AND THAT OF THE WITNESSES, TO COME TO LAKE PLACID FOR THIS HEARING. WE GATHER THIS INFORMATION FOR SEVERAL PURPOSES, WHICH WE CALL OVERSIGHT AND LEGISLATION.

BY OVERSIGHT, I AM REFERRING TO THE RESPONSIBILITY OF THE CONGRESS TO ASSURE THAT EXISTING FEDERAL PROGRAMS ARE CARRIED OUT IN ACCORDANCE WITH THE INTENT OF CONGRESS IN ESTABLISHING THOSE PROGRAMS. IN SHORT, WE WANT TO KNOW IF THE CURRENT ACID RAIN RESEARCH PROGRAMS ARE ON TARGET.

AS FOR LEGISLATION, WE NEED TO KNOW IF ADDITIONAL LEGISLATION, OR MODIFICATION OF EXISTING LAWS, IS NECESSARY TO ADDRESS THE PROBLEM OF ACID RAIN. WITH THE CLEAN AIR ACT CURRENTLY UP FOR REAUTHORIZATION, THIS IS AN EXCELLENT TIME TO BE LOOKING INTO POSSIBLE LEGISLATIVE REMEDIES TO ACID RAIN PROBLEMS. I HOPE OUR WITNESSES WILL HAVE SOME USEFUL SUGGESTIONS FOR US ALONG THESE LINES.

I WILL CLOSE BY NOTING THAT, CONSIDERING THE REAL AND POTENTIAL COSTS IN HEALTH, ECONOMICS, INDUSTRIAL CAPACITY, AGRICULTURAL PRODUCTIVITY AND INTERNATIONAL GOOD WILL AT STAKE ON THIS QUESTION, WE MUST HAVE THE FORESIGHT AND COURAGE TO ADOPT THE NECESSARY SOLUTIONS.

MR. CHAIRMAN, THAT COMPLETES MY OPENING STATEMENT. THANK YOU FOR THE OPPORTUNITY TO MAKE THESE REMARKS, AND MY CONGRATULATIONS AGAIN ON YOUR CHOICE OF HEARING SUBJECT AND LOCATION. I AM LOOKING FORWARD WITH GREAT INTEREST TO THE TESTIMONY OF OUR DISTINGUISHED WITNESSES.

Mr. **Carney**. Being a Representative of New York State from its most eastern part, Montauk Point, it is indeed a pleasure to come up to this lovely area.

It is also a pleasure as a resident of New York State to see the list of witnesses that we have. It reflects the resources that our great State has, the universities, the scientists and the work that our State government has done in this area of acid rain.

I am very pleased, as you noted, Mr. Chairman, that we have seven Members of Congress here. That is unusual considering it is September and we are winding down in a very, very busy and important session of the 97th Congress.

I would yield back my time to the Chair.

Mr. **Scheuer**. Would you like to introduce your minority colleagues?

Mr. **Carney**. I would be more than glad to take that responsibility now, introducing our colleagues.

To my left we have Congressman Jim Sensenbrenner, a member of our subcommittee from Wisconsin, and Congressman Doug Gregg, who is a member of the full Committee on Science and Technology, and two members from our State of New York, Congressman Jerry Solomon, and we have Congressman Don Mitchell to the extreme left of me.

Mr. **Scheuer**. Thank you, Congressman.

I might say, Congressman Dave Martin, who is the host Congressman, was called away on an emergency matter. He is talking to his office by phone now. He will be back directly when Speaker Fink is finished with his testimony. We will then ask Congressman Martin to give us a few words of welcome.

I would ask unanimous consent that all members be able to file their remarks for inclusion in the record, my own included.

Would any of the other members have any remarks to make now before we go ahead with our program?

[The prepared statement of Mr. Mitchell follows:]

STATEMENT OF

The Honorable Donald J. Mitchell

31st Congresssional District, New York

before the

Subcommittee on Natural Resources,

Agricultural Research and Environment

September 19, 1981

Mr. Chairman:

Each new study adds to the evidence that acid rain is the probable cause of a host of destructive effects on the environment. With studies of broader scope and more detailed design only now getting underway, the urgency to do something about the problem makes my constituents in the Adirondacks impatient with waiting for further scientific evidence before devising a plan to counteract this threat.

The measurement of declining fish populations, higher water acidity levels, stunted timber growth, lowered crop production, and increasing levels of toxicity in drinking water supplies may become more precise but do not hold promise of pointing in a different direction from studies already completed by Cornell University and the Domtar Research Center in Ontario, to name two of the pioneers in the field.

The people who live in this beautiful wilderness area have observed the changes over a period of fifty or more years. They are certain of the changes they have witnessed over a lifetime. For them, the value of the studies is not to confirm that acid rain is destroying the Adirondack environment but in convincing their fellow citizens that this is the case.

A July 5th article in the Washington Post discussed the upcoming Clean Air Act reauthorization by Congress and commented that recent polls show people are only about half as concerned about air pollution as they were a decade ago. Historically, great citizen movements in this country have culminated in the creation of a watchdog agency, like the Environmental Protection Agency, whereupon the citizens assume their job is done, and they can rely on the government to continue the good fight. We need to mobilize that interest once again on behalf of clean air.

In attempts to heighten public awareness of the acid rain problem, we are facing several obstacles, including 1) public apathy from a citizenry which assumes the problem of air pollution is less severe than it was a decade ago, 2) a perception of acid rain as a regional rather than as a national problem, and 3) energy self-sufficiency, as a national goal, which steamrolls every other value before it.

Statement of Cong. Donald J. Mitchell, September 19, 1981.

So far our efforts have been directed toward increasing public awareness; but, where acid rain is concerned, one finds himself too often "preaching to the choir." We have not got the message across to the nation that the Adirondacks are a living laboratory for the nation to study its if it opts for energy quick-fixes now.

No choice is cost-free. It is simply easier to measure the annual decrease in barrels of imported oil than it is to estimate the expense of restoring a damaged aquatic ecosystem.

I recently met with Coalition of Adirondackers to Neutralize Acid Rain Inflow officials and professionals of the New York State Department of Environmental Conservation and the Adirondack Park Agency who are witnesses to increasing damage to stands of timber and fish populations in the Park. They are convinced that time is running out for this beautiful wilderness area. They have been able to study only 850 of the Park's 3,000 lakes (about 20% are "dead"). At this pace, it will take twenty years to complete the inventory. It is inconceivable that, given the facts, the American people would stand by while a wilderness is destroyed because of insistence by energy interests that a "cause and effect" standard be proved. In most research, an inference is sufficient to take action.

Coal use is an inevitable part of the near future in energy generation, barring a shift in public acceptance of nuclear energy or the rapid development of new energy technologies. However, we can require that every pro-energy choice be accompanied by an estimate of the economic costs to the nation for losses in fish populations, timber yields, and damage to foliage crops. If tough short-term choices are to be made, they should be made with full knowledge of the consequences. Controlled laboratory studies can make reasonable predictions about these matters without our waiting for large areas of Canada and the States east of the Mississippi to suffer irreversible damage.

A National Research Council report[1] has warned us that, as strip-mined coal is depleted in the next twenty years, other types of coal- differing in the content of organic and pyritic sulfur- will foster different kinds of pollution problems requiring varying methods of pollution abatement. Some of these technologies may involve stack-gas scrubbing, fluidized-bed combustion, underground mine-site coal gasification, or conversion of coal to cleaner fuels. The worst may be yet to come, and the nation needs to know it. It is necessary for us to develop a national policy which will not be rendered obsolete because it was based on partial or faulty information.

The Science and Technology Committee has the unique responsibility for directing our technological development in the achievement of national goals which include self-sufficiency in energy sources as well as in crop production. I do not think this is an either-or choice in which we must barrel down the road toward coal conversion without due regard for the gravity of the environmental problems we may be creating.

---

[1] Chemistry of Coal Utilization: Second Supplementary Volume, Committee on ~~Chemistry of Coal Utilization,~~ Board on Mineral and Energy Resources, Commission on Natural Resources, National Research Council, Martin A. Elliott, ed. (John Wiley & Sons, 1981.)

The common ground on which skeptics and believers both stand is that aquatic ecosystems are damaged by acid rain and that the remedies for this damage, at the present time, are to lime the lakes to raise their alkaline content or to install coal scrubbers at the point of origin of the pollution.

While the technological problems in developing better solutions to this phenomenon are formidable, the question of accountability among political jurisdictions may be more difficult. It is not a matter that is easily resolved among States or among nations but is certain to shadow these relationships in other endeavors.

I appreciate the opportunity to join with so many fellow New Yorkers in presenting to the Committee our continuing concern over acid rain.

Mr. SCHEUER. At this time, it is a great pleasure and a privilege to introduce Assemblyman Fink, who has played a key role in this State in facing up to the problems of environmental degradation and particularly acid rain.

He is considered nationally one of the outstanding members of State legislatures. Speaker Fink has been in close touch with our Canadian friends, and we look forward with pleasure to hearing what he has to say.

STATEMENT OF STANLEY FINK, SPEAKER, NEW YORK STATE ASSEMBLY, ACCOMPANIED BY JOE MARTENS, ASSEMBLY PROGRAM AND COMMITTEE STAFF; RICK MORSE, LEGISLATIVE COORDINATOR, ENERGY AND ENVIRONMENT, NEW YORK STATE ASSEMBLY; AND ROBERT KURTTER, DEPUTY DIRECTOR, ASSEMBLY PROGRAM DEVELOPMENT GROUP

Mr. FINK. We appreciate the fact that you have seen fit to hold this hearing in our State, and we, on behalf of the the members of the State legislature, thank you for taking time out to conduct this hearing.

Mr. SCHEUER. I want to reiterate my thanks to you and your staff for helping in working out all the details of this hearing. They couldn't have been more cooperative.

Mr. FINK. Thank you, sir.

I bring special greetings to former colleagues in the State legislature, Mr. Solomon and Mr. Mitchell, and of course Mr. Martin, from their former colleagues in the assembly who were in session the day before yesterday and knew I was going to be here. Everybody says hello and wishes both of you particularly well.

Mr. Chairman, your observation that the acid rain problem is one of the most complex national and international problems facing society generally today is an observation that we agree with.

Its effects we believe are pervasive, including damage to plant and animal life, disruption of the natural rate of decomposition of soils, reduced productivity of farmland and forest areas, deterioration of stone buildings and monuments and an increase in the heavy metal content of drinking water, upon which we depend.

The acid rain problem is certainly not a localized problem of the Adirondacks. The lakes of northern Wisconsin, the wilderness in Minnesota, the lakes of the great Smoky Mountains in North Carolina and Tennessee and the lakes of Acadia National Park in Maine have all reached critical levels in the acidity of the waters and surrounding soils.

Yet, acid rain is an unusually difficult problem to resolve because its precise sources are very difficult and nearly impossible to identify.

While it is well known that coal-burning electric generating facilities in Ohio and in Indiana emit significant amounts of sulfur dioxide pollutants, it has not been definitely established that those pollutants are the ones that fall out as acid rain in the Adirondacks.

It has been estimated that coal-burning plants in the Ohio River Valley account for about 52 percent of all the sulfur dioxide emissions in the United States. This is due to the fact that these midwest powerplants burn dirty or high sulfur coal which is mined locally in Kentucky, Pennsylvania, West Virginia, and Tennessee. They are dirty, but of course have high Btu capabilities and therefore are used.

Moreover, since these are older powerplants, they are not equipped with scrubbers or other state of the art coal cleaning technology. Rather, the approved EPA solution to this problem was to build taller smokestacks to loft the sulfur dioxide and nitrous oxide emissions higher into the atmosphere.

Despite the lack of hard scientific evidence tracing pollutants from the Ohio River Valley to New York State, the cause and effect relationship is clear. Recently retired Supreme Court Justice Potter Stewart was widely quoted as saying about pornography, "I may not be able to define it, but I know it when I see it."

The same can be said about acid rain. We may not understand its climatic pathways or all of its sources, but we know an ecological disaster when we see it.

Acid rain in the Adirondacks today is an ecological disaster. Last August the Department of Environmental Conservation conducted a study of acid rain on New York State and found that nearly 10 percent of all of the lakes and ponds in the Adirondacks were in a critical state of acidification. Another 9 percent were found to be in an endangered state. One-fifth of all the lakes and ponds in the Adirondacks are in very grave danger.

Despite the concern and best efforts of the legislature and the State, acid rain is a Federal problem. While New York State has a constitutional responsibility to protect the public health, safety, and general welfare of its citizens, it cannot send out its State militia to close coal burning powerplants in Ohio or chase industrial polluters to the faraway Sun-Belt. Even if this paramilitary fantasy succeeded, acid rain might continue drifting across the continent and falling out in mountainous areas in the United States, Canada, and Europe.

The Federal Government must not abdicate its crucial responsibility in this area. Serious interstate and international issues are at stake. Uniform national standards are needed to insure that acid rain does not become a further source of regional and international dispute.

I might add I am not happy as an individual to come and speak particularly about a problem with our sister States in the Northeast-Midwest because I believe we have such a great responsibility and opportunity in the Northeast-Midwest quadrant to work together with sister States.

But not withstanding that, I must point out the facts as we see them with regard to places like Ohio. In New York State, we are concerned that the Congress and the Federal Government lack the will to act. In 1979, Senator Daniel Patrick Moynihan succeeded in getting the Acid Precipitation Act of 1979 enacted, which appropriated about $10 million for further studies of the acid rain problem. So far, little of that money has been spent and none of it has come to New York.

In the meantime, 17 midwestern utilities in the Ohio River Valley have petitioned the USEPA for further relaxation of sulfur dioxide emissions from their coal-burning powerplants. This proposal would enable these plants to burn more high sulfur content coal, thereby reducing the cost to their customers of producing electricity.

The proposed rule changes would also encourage conversions to coal of plants that formerly burned oil, thereby facilitating the national energy policy of reduced oil consumption.

Our real fear is not only that Congress and the Federal Government will fail to act, but further, that the new coterie of regulation cutters in Washington will further weaken the Clean Air Act, thereby exacerbating the acid rain problem.

Attorney General Robert Abrams has brought suit against the EPA to prevent them from allowing utilities in the Midwest from increasing their sulfur dioxide emissions. These so-called special limitations, if approved by EPA, could greatly increase environmental degradation in the Adirondacks and other areas vulnerable to acid rain pollution.

The 1977 amendments to the Clean Air Act are unambiguous. They say that a State may not pollute in such a manner that will prevent attainment of primary ambient standards in another State. Yet, EPA has not acted to enforce this directive and has turned a deaf ear to New York State's complaints about acid rain.

I support the Attorney General's suit and I fully expect that the courts will act to protect the people from these airborne toxic chemical wastes.

Recently, David Stockman wrote to the Coalition of Adirondackers to Neutralize Acid Rain Inflow—CANARI. Stockman wrote:

> I kept reading these stories that there are 170 lakes dead in New York that will no longer carry any fish or aquatic wildlife. And it occurred to me to ask the question . . . how much are the fish worth in these 170 lakes that account for 4 percent of the lake area of New York?
>
> Does it make sense to spend billions of dollars controlling emissions from sources in Ohio and elsewhere if you're talking about a very marginal volume of dollar value, either in recreational terms or commercial terms?

So spoke the new prophet of American capitalism.

Of course, Mr. Stockman failed to note that the average residential cost of electricity in Ohio is over 40 percent cheaper than in New York State. In order to meet air quality standards in New York City, residential customers must pay ConEd $148.67 for 1,000 kilowatthours while Cincinnati residents pay $47 for 1,000 kilowatthours.

Much of the pollution from the Midwest blows eastward, exacerbating New York State's air quality problems. However, Cincinnati only has the Great Plains farmlands to its west, thereby inheriting relatively clean air.

While the rates charged by ConEd in New York City are unconscionably high, the Midwest has long enjoyed artificially low rates as a result of burning coal. These rates are artificially low because the cost of cleaning emissions was never included as it was in New York City and in other parts of New York State, and I suspect in many of the northeastern States.

While I would not wish to impose ConEd's burdens on anyone, New Yorkers have for too long paid the full cost of clean air while other parts of the Nation were not forced to meet these higher standards.

Moreover, there are direct costs of acid rain which are now being incurred by New York State governments and businesses. Among these are the costs of liming lakes, streams and soils, the loss of commercial timber value due to slower growth, and the loss of commercial recreational activity and sports fishing.

Tourism is still the No. 1 industry in the State of New York if one takes into consideration all its component parts. Sports fishing in the Adirondacks region plays a great role in that No. 1 industry of the State of New York. These are costs borne by New Yorkers in addition to the despoliation of an irreplaceable wilderness preserve.

If that is not enough for Mr. Stockman, the Ohio River Basin Energy Study submitted to Congress this year by the EPA attributed 8,000 deaths per year to sulfur dioxide pollution in the Ohio River Valley.

Please do not misconstrue my message. I am not opposed to coal use or coal conversion. I recognize that, for New York State and much of the Nation, coal is a viable way for many utilities to reduce our reliance on imported OPEC oil. The OPEC burden is an economic and political hazard to everyone, and I suggest we must do all in our power to solve it, and coal conversion is certainly one of the major ways.

However, in New York State, we have moved slowly and deliberately on coal conversion. It is a costly procedure which must be accomplished within strict air quality guidelines.

I believe that coal can be burned cleanly using state of the art technology in scrubbers, coal washing, fluidized bed combustion, and commercially available and economically viable processes.

While New York State invests in this expensive but necessary equipment, coal-burning powerplants in the Ohio Valley are allowed to continue to operate under the antiquated philosophy of "out of State, out of mind."

In the 1960's, Ohio coal plants built taller smokestacks to reduce sulfur dioxide fallout in the immediate vicinity of the plant by emitting pollutants higher into the atmosphere. In the East, due to other air quality problems, reduced emissions had to be accomplished by burning low sulfur coal, expensive low sulfur oil, and by using state-of-the-art emissions reduction technology.

While it may cost more for Ohio utilities to meet the standards that New York State utilities must meet today, they have long benefited from this ability to export rather than clean up their pollution.

This is not to say that all solutions to the acid rain problem need to be fabulously expensive. We are not unmindful in the State of New York of the tradeoff and the obvious necessity of building our Nation's industries and our own infrastructures and spending a lot of money to do that.

We are mindful of that, but we think environmental protection need not be lost in that trade-off because of ways of making this environmental protection which are not fabulously expensive. There are reasonable, please excuse the expression, "benefit/cost" approaches to addressing this problem.

One, coal washing. Coal washing is a low cost method of reducing sulfur dioxide emissions from the burning of coal. Coal washing should be mandated for any coal with greater than 3 percent sulfur content and could reduce the amount of sulfur dioxide pollution from Midwest coal burning utilities by three million tons per year.

Two, emission caps. The Federal Government should adopt a policy of emission caps on pollutants with regional or international impacts, such as sulfur dioxide or nitrous oxide pollutants. The cap would set a statutory upper limit on the emission of a specific pollutant that would apply either to an individual plant, a State or a particular region.

The cap policy would prevent increased levels of the pollutants that cause acid rain, but would allow States and private industry the flexibility necessary to design an economically feasible solution for pollution abatement.

Three, least emissions dispatching. Electric utilities currently rely on a least cost dispatching policy; that is, the plants that are cheapest to operate have the highest priority and are utilized at maximum capacity. Unfortunately, the cheapest plants are often the older plants with little pollution control technology and the worst emissions.

Least cost dispatching minimizes costs to the utilities but fails to take into account the costs to society—costs like acidified lakes—incurred by maximizing pollution emissions.

A policy of least emissions dispatching, on the other hand, would utilize the cleanest plants on a priority basis and operate the dirtier plants at full capacity only when the need arises.

According to the Ohio River Basin energy study undertaken by the EPA in 1981, least emissions dispatching could reduce sulfur dioxide emissions by 45 percent at only a 2-percent cost in the increase in electricity.

The Province of Ontario, Canada, has shown great initiative in this area by adopting a policy of least emissions dispatching for its powerplants. We should pay careful attention to the results.

Four, reasonably available control technology. All existing coal burning powerplants should be required to install reasonably available control technology to reduce sulfur dioxide emissions.

This is not the very expensive high technology scrubbers and electrostatic precipitators New York State will have to install on its new coal burning plants. This reasonably available control technology has already been employed in the East.

Five, research. Research into the causes and effects of acid rain must be accelerated. Particular emphasis needs to be placed on the less studied aspects of soil quality, wildlife, and potable water supplies.

These five steps are not complete solutions to the problems, but they are low-cost steps which can be taken now while more serious, long-term solutions are developed.

These short-term measures should not be used to substitute or delay more serious measures, but rather should constitute a small beginning in an attempt to resolve interstate and international problems in this area.

In conclusion, I would like to say that the case is clear. While the "iron link" between coal burning in the Ohio Valley and acid rain in the Adirondacks has not been definitively established, the evidence is in.

We know the sources of this pollution and we have documented the sad result, even if the precise pathway of the pollution is muddled by our lack of understanding of meteorological patterns. We know an ecological disaster when we see one.

It is vital that the Reagan administration and the Congress not adopt the Stockman "head in the sand" attitude toward acid rain. New York State did not set aside the Adirondack preserve and protect it with the "forever wild" clause in the Constitution only to have David Stockman tell us that it is not cost beneficial to the people of Ohio to pay for the clean-up of their own pollution.

Their electricity bills are 40 percent lower than ours because they cheaply export pollutants to our environmentally protected areas, with the complete sanction of the Federal Government.

This ostrich mentality must not become the mind set of the next decade. Congress must act to force the Reagan administration to address these key interstate and international issues.

Deregulation will not make the problems of acid rain go away. If history is a wise teacher, then we should know by now that it will only be more expensive later to clean up the environmental damage.

The technological solutions to these problems are available. Low cost solutions for older powerplants are available and new coal burning plants and coal conversions should not be allowed to operate without the best available technology for sulfur dioxide and nitrous oxide emission reductions. The real task is forcing Congress and the Federal Government to recognize their responsibilities and get on with the job.

I thank you for giving me this opportunity to testify and give our opinion on this problem.

Mr. **Scheuer**. Thank you very much, Speaker Fink, for your excellent testimony, your suggestions, which came at a timely point for us because we are going to be marking up the Clean Air Act in another few months.

I am sure we will all have some questions for you, but before we get into the questions, I mentioned before that Congressman Dave

Martin, who is our host here, was called away for a very critical emergency in his district. He is now back with us, and I would like to call upon him for some word of welcome.

Mr. MARTIN. I want to thank you very much. I want to welcome everybody to the 30th Congressional District and Lake Placid. It comes as no surprise, I know, to my colleagues up here, certainly to my former leader and good friend, Speaker Fink, that from time to time an emergency comes and you have a constituent with trouble and you have to take care of the situation.

The 30th Congressional District and Lake Placid, the home of the 1980 Winter Olympics, are experiencing the most dramatic impact of acid rain.

I appreciate my colleagues coming from Washington for this hearing to get at the root of the problem, as it were. I did want to point out this is by no means the extent of the interest of the House of Representatives in the acid rain problem.

We do have problems in scheduling in the House of Representatives, as anywhere else, and I think if we had known down the road that today there would not be votes in the House of Representatives, there would be many more Congressmen here.

I think it is very important for all of us to pay close attention to these hearings because it is going to be the weight of the evidence we hear that is going to make the difference when the Clean Air Act comes before the House.

With that, Congressman Scheuer, I will turn it back to you and offer a hearty welcome to all of my colleagues.

[The prepared statement of Congressman David Martin follows:]

STATEMENT OF REP. DAVID O'B. MARTIN

THANK YOU, MR. CHAIRMAN.

I AM EXTREMELY PLEASED TO WELCOME YOU, THE MEMBERS OF YOUR SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND THE ENVIRONMENT AND MY NEIGHBORING AND CONCERNED COLLEAGUES HERE TO LAKE PLACID IN THE HEART OF OUR NORTH COUNTRY FOR TODAY'S HEARINGS AND TOMORROW'S TECHNICAL BRIEFINGS. THE PEOPLE OF THE ADIRONDACKS, I CAN ASSURE YOU, DEEPLY APPRECIATE YOUR KEEN INTEREST IN A PROBLEM THAT AFFECTS THEM SO DIRECTLY. WHILE IT'S UNFORTUNATE THAT OUR BUSINESS IN THE NATION'S CAPITAL FORCED THE POSTPONEMENT OF OUR PLANNED HEARINGS IN JULY, WE ARE FORTUNATE, INDEED, TO BE HERE AS THE LOVELY ADIRONDACKS DON THEIR COLORFUL AUTUMN WARDROBE.

IT IS, OF COURSE, A CRUCIALLY IMPORTANT MATTER THAT BRINGS US HERE TODAY, AND OUR PRESENCE WHERE THE PROBLEMS OF ACID RAIN ARE SO EVIDENT AND WHERE WE CAN HEAR ABOUT THEM FIRSTHAND FROM WITNESSES WHO ARE SO CLOSE TO THE PROBLEM, IS MOST APPROPRIATE. THE FIRST STEP TOWARD ANY PRESCRIPTION FOR ACID RAIN, AFTER ALL, IS INFORMATION --- INFORMATION THAT HAS ONLY BEGUN TO SPREAD.

IT MIGHT APPEAR TO BE A DIVERSION, MR. CHAIRMAN, FOR ME TO POINT OUT HOW IDEAL THIS SETTING IS FOR A MEETING LIKE OUR'S TODAY. THE PEACEFUL BEAUTY OF THE ADIRONDACKS CAN ONLY ENCOURAGE CALM, REASONED DIALOGUE AND REFLECTIVE THOUGHT. OUR FACILITIES COULD NOT BE MORE IDEAL FOR MEETINGS AND CONVENTIONS OF THIS NATURE, AND I HAVE PROUDLY CARRIED THAT MESSAGE TO AS MANY PEOPLE AS WILL LISTEN. I INVITE YOU TO DO THE SAME.

BUT ACID RAIN THREATENS NOT ONLY THE NATURAL BEAUTY OF THIS AREA, BUT THE ECONOMIC WELL-BEING OF OUR PEOPLE AS WELL IN ITS THREAT TO OUR GAME, FISH, AND THE TOURISTS THEY ATTRACT, ITS DANGER TO OUR FORESTS AND THE CONVENTIONEERS AND GROUPS WHO COME TO MEET AMIDST THEIR SPLENDOR, ITS EFFECTS UPON THE LAKES AND WATER SUPPLIES WHICH GIVE US SUCH ENJOYMENT AND, INDEED, OUR SUSTENANCE.

CLEARLY, MR. CHAIRMAN, THE PEOPLE OF THIS AREA DESERVE OUR PRESENCE TODAY. THEY DESERVE OUR EVERY EFFORT TO SPREAD TODAY'S TESTIMONY AMONG OUR COLLEAGUES -- PARTICULARLY THOSE FROM THE AREAS THAT WITH FRIGHTENING REGULARITY ARE ADDED TO THE LIST OF ACID RAIN'S VICTIMS. THEY DESERVE A COMMITMENT FROM US THAT WE WILL WORK TOGETHER, AMONG OURSELVES AND WITH ALL LEVELS OF GOVERNMENT, IN A HARMONIOUS WAY TOWARD AN EFFECTIVE, WORKABLE SOLUTION. THEY ALSO DESERVE AN APPROACH

THAT IS REALISTIC AND CALMLY REASONED. THOUSANDS OF OUR LAKES, PONDS, AND STREAMS STILL SUPPORT GAME FISHING THAT IS AMONG THE BEST IN THE WORLD. OUR FORESTS, AS YOU CAN SEE, ARE LUSH; OUR MOUNTAINS MAJESTIC AND OUR WATERS CLEAR. AND, BECAUSE OF THE KIND OF COMMITMENT WE WILL SEE TODAY, I AM HOPEFUL THAT WE WILL MEET THE CHALLENGE POSED BY ACID RAIN.

ONCE AGAIN, MR. CHAIRMAN, I WELCOME YOU TO GOD'S COUNTRY, I THANK YOU FOR COMING, I LOOK FORWARD TO THE TESTIMONY WE WILL HEAR TODAY AND I KNOW WE WILL ALL PROFIT FROM THESE IMPORTANT HEARINGS.

Mr. SCHEUER. Speaker Fink, can you give us some idea of the specific cost of acid rain to New York State? I don't mean to imply that the problem of acid rain can be completely met through cost-benefit analysis. I believe there are nonmonetary costs to acid rain that cannot be quantified.

As a matter of pride in America and in our national patrimony, I find it deeply offensive that we are degrading our lakes, forests, and croplands. I find that personally unacceptable, apart from financial costs, and I am sure you do, too. But to many of the Stockman mentality, costs are first, last, and always of quintessential importance.

What are the costs, as nearly as you can define them, of acid rain to the New York State economy?

Mr. FINK. I don't think I can give a dollar amount, Mr. Chairman. I can say without any question that tourism is the No. 1 industry in the State of New York. There are many people who believe that for reasons having to do with the Sun Belt and Western configuration, that tourism is the kind of industry that one can't move to another State in the Union and we have to put a lot of eggs in this basket in years to come in the State of New York.

We spend a great deal of money each year talking about New York State as a tourist mecca. There is no question about it that one of the leading tourist attractions of the State of New York is our Adirondack region with tens of millions of visitors each year.

People come to an area because of its natural beauty and its pristinelike purity. Acid rain, if not now, will certainly in the future have its economic impact on that.

I don't think there is any way I could come up with a cost analysis of the amount of dollars that this costs us now or might cost us in the future. I don't think I could give you an amount of dollars that remedial health measures will take place in the future.

I don't think I could do that. I can tell you the amount of money which we try to spend in the State of New York each year to lime our lakes and protect the environment. It runs into tens of millions of dollars.

But the question of the exact impact on our economy, I don't think there is anyone who can give you a direct answer except to note the fact that tourism is a major industry and the Adirondacks suffers most.

One can draw conclusions in the future if the area is despoiled, then the amount of money that will come to this industry will go down.

I am trying to respond to your question. One is not talking about things you are talking about, potential health hazards and the despoliation of an area which many of us have fought for many years, particularly the residents of the Adirondack region, to protect.

Mr. SCHEUER. Your answer is similar to that the Canadians give us with the additional factor that the damage to the forest products industry is of enormous consequence. That composes about 50 percent of their GNP.

We recognize that acid rain is a Federal responsibility. It crosses State lines, region lines, and it goes national in nature, poisoning not only the air but our relations with Canada and has equally poisonous effects on the relations with countries of England, France, Germany, and particularly Belgium. This is quintessentially an international problem and we recognize our responsibility.

This committee is the committee that has jurisdiction over scientific research on acid rain. Are you, as a leader in the State effort to ameliorate this question, satisfied with the order of magnitude of the Federal research effort?

Mr. FINK. Well, Mr. Chairman, we indicated that an amount of money was set aside in an act in 1979, and it is our understanding, to the best of our research capability, that the appropriation of $10 million for the study of acid research has not, as a matter of fact, been nearly expended.

Based on that, the answer would be that we think that once the money was appropriated, we would hope that it would be expended in an appropriate way to do more research.

There is always the possibility—and one never ceases to hope there is a possibility—that an appropriate amount of research, in something which is now not the state of the art, which might become the state of the art, can ameliorate these problems and, at the same time, meet the obvious desired effects of people across the Nation of not incurring or placing greater burdens and greater costs on industries across our Nation.

That is one of the hopes of research and development, that the tradeoff between the environment and future business costs need not cause a dichotomy, that maybe there is some way it can be accomplished without the expenditure of large sums of money, thereby impacting on the people in Ohio and on the Ohio River Basin in a negative way.

I can't answer that question. I am not scientifically learned enough to know, but that is what initial research should be doing, as well as initial research into the climatic pathways of acid rain formations.

Mr. **Scheuer**. That is also a challenge to industry to increase the order of magnitude of their R. & D. efforts.

Mr. **Fink**. I couldn't agree more, sir.

Mr. **Scheuer**. Congressman Carney?

Mr. **Carney**. I would like to thank the speaker for his very worthy testimony that he has brought here today.

I might note that often, when we deal with a problem as vague as acid rain, few witnesses come up with suggestions, and I see that you have, and I think very wise suggestions that deserve an awful lot of consideration.

I agree with you that the acid rain problem is a problem that the Federal Government will have to address because it doesn't know subdivisions of government, it doesn't know State lines.

I know that the chairman and the subcommittee, whose responsibility it is—EPA, that is—would be, and I know this subcommittee is committed to assuring that EPA will look at this problem, and so are the members of the subcommittee.

I have a couple of questions that I would like to ask of you.

In your restoration programs, are you getting any Federal aid to help you, like the liming of your lakes and your R. & D. into the area?

Mr. **Fink**. The answer is we are not.

Mr. **Carney**. That is an area we can look into.

You are spending approximately $10 million a year in restoration, is that correct?

Mr. **Fink**. I couldn't give you the exact amount of dollars. I think there may be people here from the State department of conservation, who might have those numbers.

The number I heard for all efforts, private and public, for liming and some research being done by lumber people, was in the area of $10 million. My staff thinks that may be an excessive amount. I am not certain.

Mr. **Carney**. I am in no way trying to throw a handgrenade, but I was just curious. There was never a reference made to a nuclear option. We are talking about cleaning up the burning of hydrocarbons.

Would you suggest that perhaps the changing of the product, of at least the utility aspect of the pollution is—would you look to an option of changing the fuel that we are losing?

Mr. **Fink**. No, I would not, and I would not for many, many reasons. When one is talking about the environment and one is talking about possible hazards to the environment, it is my opinion that one of the possibly greatest polluters of the environment is the nuclear powerplant.

So, from an environmental point of view, I would not agree that risk factor is worth it. I think there are state-of-the-art methods to clean coal and use that. I go one step further, if I might.

We did some research on our own here in the State of New York on some of our own facilities, and we are convinced that the statements to the effect it is a more economical way to go forward—nuclear power—are simply not so.

We think there is proof indicating that the ultimate cost of producing electricity on a kilowatt basis using nuclear power is much more expensive than using coal.

Unfortunately, people, when they figure kilowatt rate per hour and delivery systems, have never bothered to figure into that rate the cost of entombing nuclear powerplants, which the experts tell us must be done after a period of 40 to 50 years. They never take into consideration the cost of research and development that was necessary to develop nuclear power.

We think for economic reasons the cost of producing power by nuclear power is much more expensive than the cost of doing it by coal. Certainly in terms of the construction of new powerplants we think building coal plants is much less expensive than building nuclear plants, and the opportunity to convert from an oil plant to a coal plant is certainly much less expensive than building a new nuclear powerplant.

The cost of cleaning up and putting on later state-of-the-art scrubbers that we use here in New York State, that I am not suggesting be done in Ohio, is certainly a lot less expensive than building a nuclear powerplant.

So, for economic reasons and for environmental reasons, I would not suggest that the nuclear option is the way to solve the problem.

Mr. CARNEY. Getting back to the restoration of the lakes, do you feel if we could immediately stop the problem of acid rain, that Nature would restore the lakes in a period of time, that would perhaps not necessitate our spending money to accelerate the restoration of these lakes?

Mr. FINK. My opinion is that Nature and the Department of Environmental Conservation and Fish Hatcheries, between those two august bodies, Nature and the Department of Environmental Conservation of the State of New York, we could get it done, yes.

Mr. CARNEY. I might add that next to my voting card, the second most important thing to me is my New York State fishing license.

I agree with you, the problem of our lakes is one of large magnitude. We have to do something to correct the problem that is going on right now.

Mr. FINK. I would make one other point, sir, if I may. At a recent conference I was privileged to host here in New York, that took place in the last 2 days, we are in the throes of a major problem in the State of New York.

We have decisions to make as to whether in the years to come we want to continue a tax-cutting program that we embarked on a few years ago to make us more competitive with other States in the Union, or whether we had to spend some dollars, reinvest, if you would, in the State of New York in rebuilding our State's infrastructure, which is crumbling by many wastes.

By that I mean our highway systems our mass transportation systems, our series of public buildings, dams, waterways. One of the things that keeps cropping up the most is, as a matter of fact, that all over the State of New York, particularly in rural and suburban areas, there are water systems, drinking water systems which were built and put into place years and years ago.

Aside from the evidence that 30 or 40 percent of the water is leaking out because the systems were built 100 years ago, there is a greater degree of evidence that all over the State of New York water systems which supply small communities, that the water, as a result of toxic and hazardous wastes being dumped, many of the water systems, the drinking water systems of people in the State of New York, while not endangered to a point where they can't be used, they have been left to go unabated in years to come.

If we don't rebuild that infrastructure, if we don't design hazardous waste dumps, and if we don't do something about acid rain, who knows, but not only from a health point of view of people drinking water, but again from an economic point of view, new water systems will have to be devised and built.

So from that point of view I think your observation that we have to turn this acid rain problem around in terms of lakes, I couldn't agree with more.

Mr. SCHEUER. Would the gentleman yield?

Mr. CARNEY. Sure.

Mr. SCHEUER. Speaker Fink, you mentioned suburban and rural water systems and other infrastructure. Isn't it also true that our urban systems, are also critically threatened by age and decrepitude, being built a century ago?

Mr. FINK. There is no question about it. As you well know, Mr. Chairman, in the case of the city of New York we import our water from upstate regions, and it is brought into the city by two major water tunnels.

A couple of years ago the third water tunnel was under construction and because of the shortfall of money, the construction on that has ceased.

We are a bit concerned that if the second water tunnel would ever collapse, there would be a lot of people in the southern part of the State with no potable system who would be thirsty, as Mr. Mitchell has pointed out.

Yes, from a capital point of view, there is no question about it, that much of our infrastructure in the State of New York are crumbling. I was trying to respond to Mr. Carney's question with regard to the drinking nature of the water because there are systems which are not crumbling from age but are nonetheless being infiltrated by seepage of toxic and hazardous waste.

Mr. CARNEY. I might add this committee has a full appreciation of that because of the fact that, again, that is our responsibility, the safe drinking water.

Where I come from, we have a different problem. It is the ground water pollution. We live in one of seven identified sole-source aquifers, and this committee is working hard on that.

We realize one of our options is to get our water through the up-State facilities that New York City is using right now, and we realize the cost of that. It comes down to the old Fram commercial. You can pay me now or you can pay me later. I think everybody has seen that on television.

It is probably going to be a lot cheaper to protect our water resources, both surface and ground, than it will be to try to restore them after they are polluted.

I think, Mr. Chairman, at that point I will yield back the balance of my time to the Chair.

Mr. SCHEUER. Congressman Sensenbrenner?

Mr. SENSENBRENNER. I commend you for holding these hearings on an important and timely subject. I would commend Speaker Fink for his appearance here, coming up with some specific suggestion on what the Federal Government can do in discharging its responsibility to attempt to curtail acid rain and its very serious effects.

Despite your criticism of Mr. Stockman at several places in your testimony, I don't think that really anybody seriously wants to disregard a cost-benefit analysis on this issue, or any other issue. I don't think that the fact that people in New York City pay three times as much for electric power as those who live in Cincinnati is solely due to the pollution controls that have been placed on electric generating facilities that serve the New York area.

My question of you, Mr. Speaker, is, have you determined increased costs per kilowatt hour, approximately how much of the four specific suggestions that you have made for the Federal Government to take action on, would impose on people in the Ohio River Valley?

Mr. FINK. No, we have not. We have not only because it really depends upon the size of the particular facility and the amount of kilowatts or megawatts it generates. It also depends upon—at least in one of the questions as to which powerplant to use during the peak hour period—what are the capabilities.

I believe that that information is readily available, and I would have no problem asking my staff to attempt to use the guidelines of other States where each of the other methods are in place and what the kilowatt impact is.

I would be delighted to undertake that charge and get it to your committee as soon as possible, particularly sending a copy to you. I think it is readily available as to what might be the kilowatt-hour generating cost increase for all of the various alternatives which are environmental safeguards.

[The information Speaker Fink provided for the record, follows:]

THE ASSEMBLY
STATE OF NEW YORK
ALBANY

STANLEY FINK
SPEAKER

The Honorable James H. Scheuer
Chairman
Subcommittee on Natural Resources,
Agricultural Research and the Enviromment
U.S. House of Representatives
Rayburn House Office Building, Suite 2321
Washington, DC 20515

Dear Congressman ~~Scheuer~~ Jim

On September 18, 1981, I testified at the Subcommittee's public hearing on Acid Precipitation which was held in Lake Placid, New York. At that time, several members of the Subcommittee requested that I submit additional information regarding the costs of implementing several of the recommendations I proposed.

In my prepared testimony, I urged that Congress mandate four specific policies:

1. Coal washing for any coal with greater than three percent sulfur content;

2. Emissions caps on sulfur dioxide and nitrogen oxides pollutants;

3. Least emissions dispatching for coal and oil burning power plants; and

4. Installation of reasonable available control technology for all coal- and oil-burning power plants.

In my testimony, I noted that in the past the emissions problem was solved by lofting these emissions higher into the atmosphere by building taller smokestacks. Thus the "export" of such pollution became cheaper than the cost of reducing emissions. However, the cost is only cheaper because the recipient or "importer" of such pollution has not been considered. Clearly, this is the crucial interstate and international nature of the acid precipitation problem.

In estimating the cost of implementing the measures which I have recommended, it is important to note that these direct costs do not occur solely to electric utility companies. Under existing programs, all coal-fired boilers, whether commercial, industrial or public utility, would be subject to these standards. Thus the costs must be computed as costs to individuals and industry, not only as an increase in electric utility costs.

Estimates of such costs under various scenarios have been done by the National Commission on Air Quality and the Ohio River Basin Energy Study. In addition, DOE and EPA have jointly sponsored two studies, the results of which should be available later this year.

For the Subcommittee's information, I have enclosed copies of the relevant sections of the NCAQ report and the Ohio River Basin Energy Study. If I can be of any further assistance, please contact me.

Sincerely,

Stanley

SF/rtl

Enclosure

TO BREATHE CLEAN AIR

Report of

THE NATIONAL COMMISSION ON

AIR QUALITY

Washington, D.C.
March 1981

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CHAPTER 9: ATMOSPHERIC TRANSPORT

In recent years, air pollutants transported long distances from emitting sources have been recognized to have effects that are not mitigated adequately by meeting air quality standards in the vicinity of the source of the pollution. The pollution control programs established under the Clean Air Act were designed primarily to address ground-level air quality problems caused by high ambient concentrations relatively near the pollution sources. Those programs generally have required only limited consideration of effects of emissions dispersed into areas far downwind. However, the long-range transport and chemical transformation of some air pollutants cause emissions to have important effects much farther from the source than had previously been believed.

Several problems have been found to be associated with long-range pollutant transport transcending political jurisdictions. Among the most serious are acid deposition (including acid rain and dry deposition of acid), the deterioration of visibility on a regional scale, the transport of ozone and ozone precursors between neighboring areas, and the increasing amount of interstate air pollution. All of these effects can hinder efforts to improve air quality through existing state and local regulatory programs.

INTERSTATE POLLUTION AND THE STATE IMPLEMENTATION PLAN PROCESS

The state implementation plan process focusses on the control of sources within a state to attain ambient standards in that state; pollutants transported beyond state boundaries often escape regulation. Sections of the Act that address abatement of interstate pollution have proved ineffective. Section 110(a)(2)(E) of the Act provides that the Environmental Protection Agency (EPA) is not to approve any state implementation plan that allows pollution that would "prevent attainment or maintenance" of any ambient standard in another state. However, EPA has not issued regulations clarifying that directive. Thus, no real guidance has been provided on how states where pollution originates and states receiving pollution from other states might equitably divide the burden of reducing interstate pollution.

Section 126 allows a state or local government to petition EPA to require emissions reductions from a source in another state that violates the prohibition in Section 110. In part because of the difficulty of concluding that a single source in one state prevents another state from meeting an ambient standard, EPA has not yet acted on any petitions under Section 126, although several have been filed.

LOCAL AIR QUALITY AND LONG-RANGE TRANSPORT

Present requirements based on local ambient concentrations do not reflect consideration of the cumulative effect of numerous pollutants that are transported up to hundreds of miles from the source. Because the control emphasis has been on local, ground-level effects, sources have had an incentive to disperse pollutants upward or outward, thereby contributing to their long-range transport.

For example, a recent EPA study reports that more than 175 smokestacks higher than 500 feet have been constructed since 1970. All but eight of these stacks are at powerplants that emit sulfur and nitrogen pollution, which can contribute to visibility deterioration and acid deposition in distant areas (EPA, 1979).

The national ambient air quality standards are the cornerstone of the Clean Air Act program for the control of pollution from existing stationary sources. However, the key factor associated with the most serious environmental effects of a problem such as acid deposition is not ambient pollutant concentration but rather total pollutant loading, which is only indirectly linked to ambient concentrations (ELI, 1981). Large quantities of pollution can be released without violating ambient standards in an area if the emissions are sufficiently dispersed. Therefore, it is possible for a state to institute a control program sufficiently stringent to protect local health, as defined by primary national ambient air quality standards, but that still permits pollutant emissions that can cause serious acid deposition problems in distant downwind regions.

Control technologies exist that can achieve far greater emission reductions of pollutants that contribute to these transport problems than is required to meet air quality standards, especially for sulfur dioxide. However, because the primary (health-related) ambient standard for sulfur dioxide has been attained in most of the nation's air quality control regions, only limited further reductions of sulfur dioxide emissions are expected to result from requirements for meeting primary standards.

Another difficulty in adequately controlling pollutants transported long distances concerns the ambient standards themselves. Sulfates and nitrates, which are fine particles integrally involved in acid precipitation and visibility problems, are not directly regulated. The standards focus instead on the gaseous pollutant precursors, sulfur dioxide and nitrogen dioxide.

The secondary air quality standards, which are intended to protect the public welfare, are established as ambient concentrations that are to be achieved uniformly throughout the nation. These national secondary standards do not adequately address regional air quality problems because they do not induce consideration of pollution effects in areas distant from pollution sources, do not take into account variations among regions in the importance of air-quality-related welfare benefits relative to other regional welfare needs, and may not adequately reflect air-quality-related values that exist only in certain regions of the country.

The long-range transport of air pollutants, particularly of pollutants contributing to acid deposition, has become an international concern. Canadian government officials say they regard acid deposition as Canada's most critical environmental problem. The United States and Canada have formed a bilateral research consultation group to investigate the transboundary long-range transport problem. The United States "exports" about four times as much sulfur oxides to Canada as it "imports" from that country (Altshuller and McBean, 1980).

CONTROL OF TRANSPORT UNDER THE ACT

Existing control programs under the Act are largely based on state and local jurisdictions and do not directly address the phenomenon of long-range pollutant transport. However, some reductions in transported pollutants result from programs designed primarily to meet local air quality objectives--that is, from the nonattainment and prevention of significant deterioration programs and from federally established emissions standards. The new source performance standards and the federal motor vehicle emissions control program are the most significant of the federal emissions standards.

Commission studies suggest that the nonattainment program is the most effective existing program in controlling long-range ozone and sulfate transport, primarily because it reduces existing source emissions within a region. In the Northeast, where the transport of ozone between urban areas contributes to regional nonattainment of the ozone national ambient air quality standard, projections from one study indicate that the nonattainment program will significantly reduce the amount of ozone available for long-range transport (GCA, 1980).

The nonattainment program also helps to reduce the formation and transport of sulfates to the Northeast, by requiring the reduction of sulfur dioxide emissions from existing sources in many areas of the Midwest. Enforcing compliance with existing emission limitations in state implementation plans would result in significant reductions of sulfur dioxide emissions from these sources (TRI, 1980a). However, there are a number of proposed revisions to state implementation plans that would relax many of these emissions limits. If these proposals are approved, there would be little overall reduction in sulfur dioxide emissions from major sources. In addition, new source growth will increase total emissions in some parts of the Midwest. Nitrogen oxides emissions are expected to continue to increase even with the Act's programs to control their growth; thus, the suspected contribution of nitrogen oxides to fine particulate concentrations and acid deposition will not be affected by requirements of the nonattainment program.

Programs designed to control emissions growth from stationary sources, such as the prevention of significant deterioration and new source performance standards programs, will be effective in reducing the growth rate of transported emissions but not in reducing the current levels of transported pollutants. In most cases, existing source emissions will continue to be responsible for the major portion of transported pollution generated over the next 10 to 15 years.

The federal motor vehicle control program, however, will significantly reduce motor vehicle emissions that contribute to the formation of ozone and nitrogen oxides.

THE NONATTAINMENT PROGRAM

In areas that fail to meet any national ambient air quality standard, the nonattainment provisions of the Act require reductions in emissions from existing sources, as well as stringent review of proposed new sources, in order to move the area toward attainment of the standards.

Because many more areas of the country are subject to requirements to reduce levels of ozone than of any other pollutant, the nonattainment program is likely to be more effective in mitigating ozone transport than in reducing other transport problems. To determine how the control of precursor emissions in one urban area can affect air quality in an adjacent urban area, the Commission examined the possible effect of control measures applied to hydrocarbon sources in the New York metropolitan area on the generation and transport of ozone downwind to Connecticut (GCA, 1980). The one-hour average national ambient air quality standard for ozone has frequently been exceeded throughout this region. Some of the highest measured ozone values have occurred in Connecticut, where the local emission rates of ozone precursors--nitrogen oxides and nonmethane hydrocarbons--are approximately 10 times lower than the rates in the New York metropolitan area. The transport of ozone and its precursors from the New York City area appears to play an important role in determining ozone concentrations in Connecticut.

The Commission study simulated the transport of ozone originating in Hudson County, New Jersey, at 8 a.m. and reaching Hartford, Connecticut, at 6 p.m. Analysis of the information gathered indicated that, in the absence of any ozone transported from the New York-New Jersey area and with full implementation of the 1979 state implementation plan in Connecticut, the Hartford site would meet the ambient standard for ozone by 1987. Implementation of the 1979 state implementation plan measures in the New York metropolitan area, which will reduce 1987 hydrocarbon emissions by 25 percent, may reduce 1987 ozone levels in Connecticut by 30 percent to 40 percent. However, even with full implementation of the 1979 state implementation plan control measures throughout the study region, maximum ozone levels in Connecticut will still exceed the ambient standard in 1987.

The study also showed that an additional reduction of hydrocarbon emissions, by more than 50 percent, was possible in the New York and New Jersey section of the study area. Few economic effects were expected for most source categories. (The economic effects of implementing additional control measures are discussed in Part 4, Chapter 1.) Even with these further reductions, the study predicted that the entire area, including the Connecticut portions, would still fail to meet the ozone standard by 1987.

The effects of sulfur dioxide nonattainment control measures on the formation and transport of sulfates were examined in a small portion of the Ohio River Valley (PEDCo, 1980). Sulfur dioxide emissions within this area constitute approximately 5.5 percent of an estimated 25 million tons of sulfur dioxide emissions in the eastern United States (Husar et al., 1980). Approximately 80 percent of these emissions come from powerplants.

The study estimated the contribution of emissions of sulfur dioxide from sources in the study area to sulfate concentrations in local and distant areas. Approximately 15 percent of the sulfate in the study area was found to be of local origin, with the remainder imported largely from areas to the south and west. Further, it was estimated that sources in the selected part of the valley contribute between 5 percent and 10 percent of the sulfate concentrations measured over the northeastern United States. The higher figure was estimated to be the area's contribution to sulfate levels in Pennsylvania.

Approximately three-fourths of the sulfur dioxide emissions in the study area originate in nonattainment areas. Implementation of control measures in the revised 1979 implementation plans, as well as enforcement of emission limits established prior to 1979, would result in reducing emissions from existing sources 15 percent below current actual emissions. However, by 1987, even assuming compliance with all state implementation plans emission limits, total sulfur dioxide loadings in the region would increase, primarily because of the addition of new sources in portions of the region that are in attainment.

Additional emissions reductions were determined to be possible in the study area. The Ohio River Valley study estimated that the application of control measures more stringent than those needed to bring the area into attainment could result in additional emissions reductions of 15 percent to 22 percent (compared to estimated 1987 levels with state implementation plan controls). Further reductions were considered possible, although the imposition of such controls could have significant economic consequences for certain industries in the region, particularly steel and utilities (see Part 4, Chapter 1).

THE PREVENTION OF SIGNIFICANT DETERIORATION PROGRAM

The prevention of significant deterioration program requires the use of the best available control technology on all major new or modified sources that propose to locate in areas attaining the national ambient standards. In the absence of these prevention of significant deterioration requirements, stationary sources of hydrocarbons and nitrogen oxides could locate or expand in these areas after meeting all applicable state and federal emission control requirements.

These requirements may result in less emission reduction than corresponding best available control technology determinations. New source performance standards have not been issued for most categories of hydrocarbon sources, and minimal requirements have been adopted for the control of nitrogen oxides. New uncontrolled emissions of hydrocarbons and nitrogen oxides could, to some extent, aggravate ozone transport problems and could be more serious if they contribute to ozone levels in areas that currently fail to meet the ambient standard for ozone. In the Northeast, hydrocarbon emissions from industrial sources are expected to decrease; however, the effect this will have on ozone formation and transport is not known.

Nitrogen oxides emissions in the Midwest are expected to increase, continuing to contribute to existing problems with fine particulate loadings and acid deposition. More stringent control of nitrogen oxides emissions, under best available control technology requirements, could reduce this increase. Because little is known about the relationship of nitrogen oxides emissions to the formation and transport of nitrates, it is not possible to predict what effect this increase will have on the amount of fine particulate matter available for long-range transport and on the relative contributions to acid rain in the Northeast.

Emissions of sulfur dioxide in the West are expected to increase. In the part of the Four Corners region of Arizona, Colorado, New Mexico, and Utah studied by the Commission, sulfur dioxide emissions are expected to increase by 10 percent to 75 percent by 1995 under current control requirements, depending on the level of growth in the area. In the absence of more stringent best available control technology or state requirements, the range of the increase would be between 30 percent and 140 percent (LASL, 1980).

NEW SOURCE PERFORMANCE STANDARDS

As of December 14, 1980, new source performance standards had been promulgated for 31 categories of sources, most of which are major sources of sulfur dioxide and particulate matter. At a mimimum, these new plants must meet the federal new source performance standards, which require a significant level of control of their emissions.

In most instances, however, new source performance standards will probably only slow the growth of emissions that contribute to problems associated with long-range transport, rather than cause reductions from current levels. The effectiveness of the standards in slowing emissions growth will depend on how many categories are covered and how stringent the control requirements are. At present, few source categories of hydrocarbons are covered by these standards. The new source performance standards program has had minimal effect in mitigating long-range ozone transport; however, EPA has begun to propose and promulgate standards for hydrocarbon source categories. (For further discussion of new source performance standards, see Part 3, Chapter 7.)

FEDERAL MOTOR VEHICLE CONTROL PROGRAM

As of 1980, motor vehicles contribute approximately 34 percent of nationwide hydrocarbon emissions and approximately 29 percent of nitrogen oxides emissions. The percentage contribution from vehicles varies among different areas of the country, but in all areas emissions from vehicles constitute a significant portion of the total emissions of these pollutants.

The federal motor vehicle program is expected to reduce nationwide mobile source emissions of hydrocarbons and nitrogen oxides by approximately two-thirds and three-quarters, respectively, between 1979 and 1987. Although reductions of mobile source emissions in areas upwind of areas affected by the long-range transport of ozone or its precursors will contribute to air quality improvements in those affected areas, the extent of those improvements cannot be predicted from current knowledge.

POLLUTANTS OF CONCERN

Two classes of transported pollutants that are of special concern are photochemical oxidants (primarily ozone) and fine particles (those with diameters of less than 2.5 microns).

Ozone, a major constituent of smog, is a powerful oxidizing agent that may cause functional, biochemical, and structural changes in the lung. Ozone may also damage susceptible crops at concentrations lower than the ambient standards (U.S.-Canada Memorandum of Intent, 1981).

Fine particles contribute to regional acid deposition and visibility impairment; they also pose threats to human health because of their ability to carry trace metals, carcinogens, mutagens, and other potentially toxic substances into the periphery of the lung, from which they are removed relatively slowly (NRC, 1978). Toxicological studies have shown that inhalation of sulfates in the form of sulfuric acid particulates is hazardous to the lung (Leikauf et al., 1981).

Both classes of pollutants are coming under increasing scientific scrutiny. EPA has begun a 4-year research program to learn more about the formation and transport of ozone in the Northeast. The program, which has received between $6 million and $8 million annually, is to begin to yield results in 1983. Questions surrounding the formation, transport, and effects of acid precipitation are to be examined by an interagency task force established by Title VII of the Energy Security Act of 1980. That study, which will expand work already underway at EPA, the National Oceanic and Atmospheric Administration, the Department of Energy, the Department of Agriculture, and other agencies was initially authorized at $50 million and is to last 10 years. Current knowledge about the formation and long-range transport of these classes of pollutants is summarized below.

OZONE

Hydrocarbons and nitrogen oxides combine in the presence of sunlight to form ozone. The major emitters of hydrocarbons in the United States in 1978 were industrial processes (approximately 50 percent) and motor vehicles (approximately 34 percent). Nitrogen oxides are primarily formed by fuel combustion. Stationary sources contributed approximately 55 percent and mobile sources approximately 30 percent of nationwide nitrogen oxides emissions in 1977 (EPA, 1980b).

The transport of ozone and its precursors over short distances by local weather patterns, or over longer distances and larger areas by broader weather systems, is considered a common occurrence. The contribution of ozone transported long distances to high ozone measurements in a particular area varies according to the topography, local meteorological conditions, and the quantity and mix of emissions. This contribution is greater in regions in which urban areas are close to one another, as in the northeastern United States, and where local meteorological conditions cause atmospheric recirculation from day to day. Elevated ozone concentrations are known to exist 50 miles to 75 miles from major sources of hydrocarbon and nitrogen oxides emissions (Deane, Snowdon, Shutler, Garrish, and Gherardi, 1980).

Compliance with the national ambient air quality standards for ozone in a particular region may be hindered by the presence of transported ozone. Under certain conditions, ozone can be transported over long distances (up to 600 miles). Ozone buildups are observed in conjunction with stagnating high pressure systems, which have limited ventilation and high solar radiation; as these systems move across areas of high emissions densities, elevated ozone levels tend to occur on the trailing edge of the system. Irradiation of less reactive emissions can contribute to high ozone levels far from emissions sources. The role of areas with relatively low levels of emissions of hydrocarbons or nitrogen oxides in this type of transport may be significant, but it is difficult to determine.

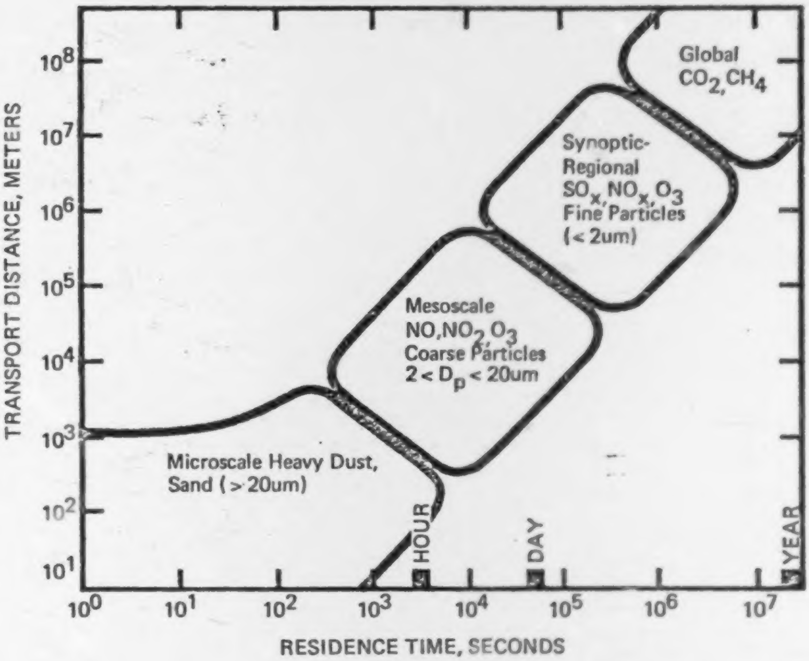
FINE PARTICLES

Fine particles are formed directly by combustion, by the coagulation of smaller particles, and by gas-to-particle conversion in the atmosphere. Natural sources such as volcanoes and sea spray also contribute fine particles to the atmosphere. Fine particles can persist in the atmosphere for as long as 2 to 6 days and can be transported hundreds of miles (Figure 3.9.1). The most common constituents of fine particulate matter are sulfates, nitrates, particulate organic matter, and trace metals (of which lead is found most often).

Sulfates and nitrates are formed by the chemical transformation of sulfur oxides (mostly as sulfur dioxide) and nitrogen oxides in the atmosphere. Although natural sources contribute to the presence of sulfur oxides in the atmosphere on a global scale, the principal sources of sulfur dioxide over the United States, particularly the eastern half, are manmade (Whelpdale and Galloway, 1979). The relative contributions of natural and manmade sources of nitrogen oxides in the atmosphere are not as well understood as those of sulfur oxides. On a global scale, natural sources may contribute substantially more nitrogen oxides than manmade sources; however, the natural sources are extremely variable. Over industrialized areas such as those in many parts of the eastern United States, where manmade sources are relatively concentrated and emissions are relatively constant, the manmade sources are the principle contributors of these substances.

Approximately 55 million tons of sulfur dioxide and nitrogen oxides are emitted into the atmosphere each year by manmade sources in the United States, with 65 percent of the

FIGURE 3.9.1 Atmospheric Dispersion of Air Pollutants



The residence time of different air pollutants and the mean transport wind speed determine their scale of dispersion in the atmosphere. Manmade sulfur compounds, including fine particles, are distributed on synoptic-regional scale.

SOURCE: Husar and Patterson, 1979. Courtesy of the World Meteorological Organization.

sulfur dioxide and 30 percent of the nitrogen oxides emitted by electric utilities (EPA, 1980b). Older coal-fired powerplants may emit five to seven times the amount of sulfur dioxide permitted for new, well-controlled facilities. When these emissions are from tall stacks, the likelihood for long-range transport is increased. Table 3.9.1 shows estimated emissions of nitrogen oxides, sulfur oxides, and particulate matter from various categories of sources in the eastern half of the United States.

Sulfur dioxide and nitrogen oxides are emitted into the atmosphere as gases; they are then either removed by dry and wet deposition processes or transformed by a variety of chemical reactions. Sulfur dioxide is probably deposited primarily through dry deposition, although a small fraction is transformed chemically into particulate sulfate. The oxidation of 1 ug/m^3 of sulfur dioxide produces approximately 1.5 ug/m^3 of sulfate. The atmospheric residence time of sulfur dioxide is between 1 and 2 days. However, sulfate can remain in the atmosphere as long as 6 days and can be transported hundreds of miles (Husar and Patterson, 1979).

The removal processes and chemical conversions involving nitrogen oxides are not so well understood as those involving sulfur dioxide. Nitric oxide, which is the gaseous form of nitrogen-bearing emissions from stationary and mobile sources, is rapidly oxidized into another gas, nitrogen dioxide. Nitrogen dioxide may react to form gaseous nitric acid or particulate nitrate. Gaseous nitric acid is very soluble and is probably removed from the atmosphere more quickly than particulate nitrate, which like particulate sulfate may remain in the atmosphere as long as 5 to 6 days (NRC, 1977). Chemical transformations of gaseous sulfur dioxide to particulate sulfate and of gaseous nitrogen oxides to gaseous nitric acid and particulate nitrate are enhanced by certain atmospheric conditions, certain catalysts (e.g., vanadium, iron, manganese), and the presence of other pollutants such as ozone and reactive hydrocarbons. Chemical compounds that enhance the transformation of sulfur dioxide and nitrogen oxides come largely from manmade sources.

Particulate organic matter may result from either manmade or natural sources. Estimates from data collected in the Los Angeles area indicate that approximately 3 percent of organic gases are transformed to particles (SAI, 1980).

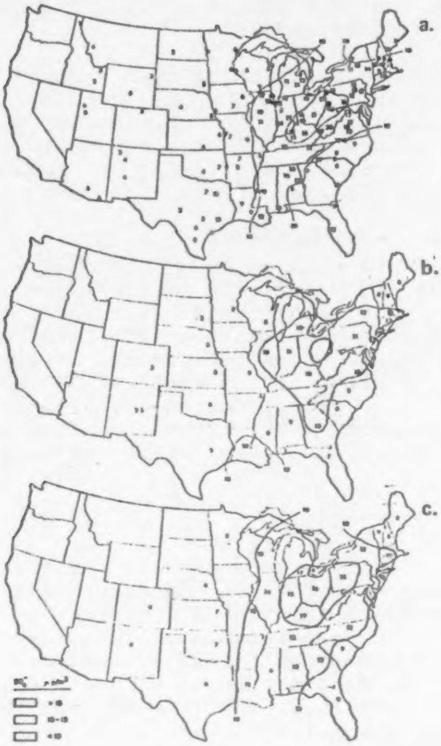
Figure 3.9.2 shows 1974 seasonal and geographic distributions of sulfate concentrations. East of the Mississippi River, high concentrations of sulfate may persist

TABLE 3.9.1 Seasonal Average Emissions (in tons per day)

	Winter	Spring	Summer	Fall
Sulfur Dioxide				
Utility	52,000	48,700	52,500	50,100
Industrial	36,500	33,000	31,600	33,500
Commercial	6,700	2,700	900	2,700
Residential	2,200	700	50	700
Transportation	1,300	1,500	1,600	1,500
TOTAL	99,000	86,600	86,600	88,500
Nitrogen Oxides				
Utility	11,400	10,600	11,600	10,800
Industrial	7,500	6,500	6,000	6,600
Commercial	2,100	800	200	800
Residential	1,600	500	30	500
Transportation	14,000	16,500	18,200	16,700
TOTAL	36,600	34,800	36,100	35,400
Total Emitted Particulates				
Utility	46,300	44,500	45,000	45,200
Industrial	31,400	33,500	5,700	5,100
Commercial	4,100	1,600	400	1,500
Residential	2,000	600	25	600
Transportation	2,900	3,400	3,700	1,400
TOTAL	46,300	44,500	445,000	45,200

SOURCE: Lavery et al., 1980.

FIGURE 3.9.2 Distribution of Sulfate Concentrations, 1974: (A) Annual Average; (B) Winter Average; (C) Summer Average



SOURCE: NRC, 1978.

as long as 5 days and cover a large area. Regional episodes of high sulfate concentrations have been linked to meteorological systems that occur more frequently during the summer; monthly average concentrations of sulfate are generally highest during that season. Seasonal variations of sulfate concentrations are less pronounced in areas that have major sources of sulfur dioxide because of the significance of such local contributions to sulfate formation (AER, 1981b).

The geographic distribution of high concentrations of nitrates is more variable than that of sulfates. High nitrate concentrations occur primarily in urban areas, which suggests the greater importance of contributions from local nitrate sources compared to contributions from the transport of nitrate from distant sources (Mueller et al., 1978).

In some areas, local concentrations of fine particulate matter are sensitive to wind patterns that carry particles from upwind source areas and to certain meteorological conditions known to be conducive to long-range transport. A lack of significant correlation between known levels of emissions from local sources and local concentrations of pollutants, the detection in local ambient air of material not characteristic of local sources, and regional episodes of elevated concentrations over areas with diverse local sources also indicate the effects of long-range transport mechanisms.

REGIONAL AIR QUALITY MODELLING

Regional air quality models provide information about the relationship between emissions in one area and air quality impacts long distances away. These models are designed to simulate transport and deposition over large geographic areas and should not be confused with models used for local air quality analyses. In contrast to such local models, which become less accurate further away from the source, regional models incorporate assumptions that are most appropriate for longer transport distances; regional models are least accurate in the vicinity of a source. Regional models do not consider emissions from a specific point source but rather include emissions from a source area. The size selected to represent the source area, the characteristics ascribed to the emissions from this area, and the size of the receptor area selected for examination have significant effects on the estimated contribution of a source area to an impact in a receptor area. Typically, regional models group sources into areas on the order of several thousand square miles. If larger areas are selected, important source-receptor relationships may be masked through large-scale averaging. If smaller areas are selected, a regional model would not be appropriate to determine source-receptor relationships because of the small-scale resolution required.

Although the results of a number of state-of-the-art regional models produce different numerical estimates, they do provide indications of the extent of the transport problem and of the relative importance of various source areas. For example, one model (Shannon, 1979) suggests that sources in the Ohio River Valley may be responsible for nearly 70 percent of the annual sulfate concentration in central Pennsylvania, 35 percent of the annual sulfate concentration in the Adirondack Mountains in northeastern New York State, and about 25 percent of the annual sulfate concentration in eastern Ontario and southwestern Nova Scotia (AER, 1981c). Similar results are indicated by another model (Mills, 1980) which suggests that more than 65 percent of the annual sulfate concentration in Pennsylvania may be attributable to emissions from the states of Illinois, Indiana, Kentucky, Ohio, Tennessee, and West Virginia (AER, 1981c). This model also suggests that between 75 percent and 90 percent of annual sulfate concentrations in any state in the eastern half of the United States may originate outside that state (AER, 1981). A third regional air quality model provides interregional comparisons of the amount of sulfur deposited on the ground. This model suggests that about 55 percent of the annual sulfur deposition in the New England states is attributable to sources outside that region, with about 15 percent attributable to sources in New Jersey and New York, about 10 percent attributable to sources in Maryland, Pennsylvania, Virginia, West Virginia, and the District of Columbia, about 20 percent attributable to sources in southern Ontario and southern Quebec, and about 5 percent attributable to Illinois, Indiana, and Ohio. Similarly, this model suggests that about 70 percent of the amount of sulfur deposited annually in New Jersey and New York is attributable to sources outside that region, mostly from sources in the Mid-Atlantic states and in Illinois, Indiana, and Ohio (Bhumralkar et al., 1980).

Regional air quality models can also be used to estimate the effects of alternative emission limitations. For example, a reduction in emissions from powerplants in the six-state area of Illinois, Indiana, Kentucky, Ohio, Pennsylvania, and West Virginia to a maximum of 3.5 pounds of sulfur dioxide per million Btu would represent an average statewide reduction in emissions of about 15 percent (although the amount of reduction would vary greatly among the states). A reduction of 15 percent in emissions of sulfur dioxide from these states would result in reductions in annual sulfate concentrations of about 10 percent in central Pennsylvania and about 5 percent in the Adirondack Mountains. Similarly, a reduction in emissions in these six states, to a limitation of 1.2 pounds of sulfur dioxide per million Btu (representing an average statewide reduction of about 35 percent), would result in a reduction in annual sulfate concentrations of about 30 percent in central Pennsylvania and about 15 percent in the Adirondack Mountains (AER, 1981c).

Regional air quality models provide an indication of the magnitudes of effects attributable to long-range transport and of the magnitudes of expected changes from emission reduction strategies. However, small differences in results from different models should not be used as a basis for choosing between alternative emissions reduction strategies. Model estimates and reliable field observations are expected to agree within a factor of two on an annual basis (Ferguson and Machta, 1981).

ACID DEPOSITION

One example of atmospheric deposition, that is, the removal of material from the atmosphere by natural processes, is acid precipitation.* A schematic diagram of the processes involved in atmospheric deposition and the important pathways for aquatic and terrestrial effects is shown in Figure 3.9.3. The amount of acid deposited from the atmosphere has been of concern since the early 1950s, when scientists determined that acid deposition was related to chemical and ecological changes in rivers and lakes in Scandinavia. Acid deposition also has been linked to damage of building materials, painted surfaces, and statues. In addition, acid deposition is suspected to cause crop damage, to reduce forest productivity, and to contaminate drinking water by the release of toxic material from soils and pipelines (Cowling, 1980).

Aquatic ecosystems are vulnerable to the effects of acid deposition in a number of ways. The sudden injection of acid

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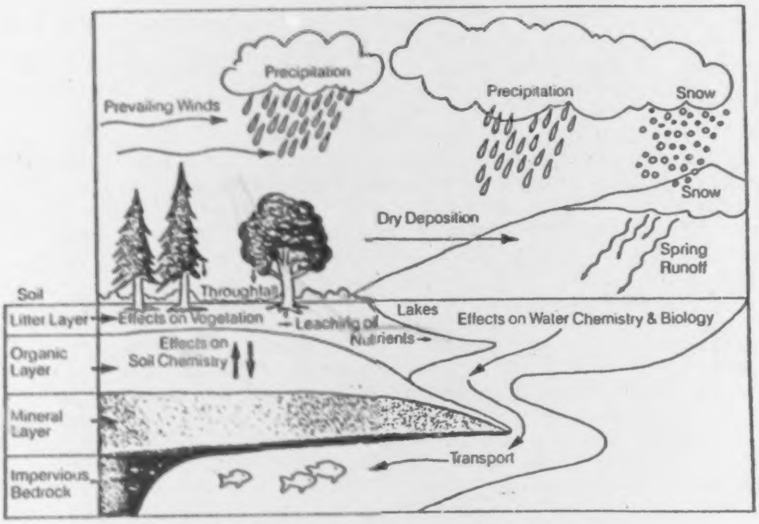
* Precipitation is naturally somewhat acidic (with a pH of about 5.6) because of the dissolution of atmospheric carbon dioxide to form carbonic acid. The term "acid precipitation" is generally applied to precipitation with pH lower than 5.6, indicating that sources other than carbon dioxide cause the acidity. A whole number change in the pH value indicates a tenfold change in acidity.

FIGURE 3.9.3 Processes and Pathways of Atmospheric Deposition


Precipitation
Prevailing Winds
Precipitation
Snow
Snow
Dry Deposition
Spring Runoff
Soil
Throughfall
Litter Layer
Effects on Vegetation
Leaching of Nutrients
Lakes
Effects on Water Chemistry & Biology
Organic Layer
Effects on Soil Chemistry
Mineral Layer
Impervious Bedrock
Transport

SOURCE: Ontario Ministry of the Environment, 1980.

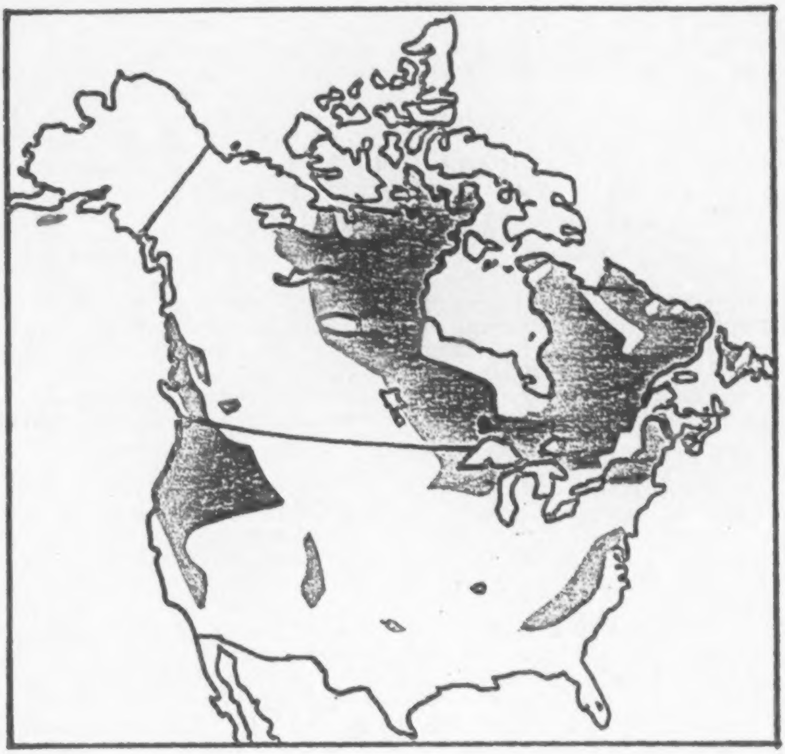
during the spring thaw from accumulations in winter snows can kill even mature fish. Increased river and lake acidity also affects the hatching of fish eggs and the ability of young fish to survive. Materials leached from surrounding soils by acidic solutions may be biological toxicants.

The effects of acid deposition on terrestrial ecosystems are not as easily detectable as the impacts on aquatic ecosystems. Effects on vegetation, for example, include the leaching of important elements and compounds from the plant, increased vulnerability to plant pathogens, and higher susceptibility to drought (Cowling, 1980). Forests in areas with acid-sensitive soils (e.g., eastern Canada) are considered particularly vulnerable. Sulfates and nitrates are important plant nutrients, and those supplied by atmospheric deposition may have beneficial effects on vegetation in areas where these nutrients are deficient (CEQ, 1981).

Acidity and toxic substances (e.g., heavy metals) have been observed to increase in many lakes and rivers, particularly in New England and southeastern Canada, over the past several decades. The sensitivity of lakes and rivers to acid deposition varies, depending on the buffering capacity (degree of alkalinity) of the surrounding soils. Figure 3.9.4 shows areas of the United States where lakes may be especially sensitive to acid deposition. Increased acidity has resulted in more than 100 fishless lakes in the Adirondack area of New York, more than 140 fishless lakes in the Canadian province of Ontario, and more than 15,000 fishless lakes in Sweden. Several thousand lakes in Minnesota and Wisconsin and 48,000 lakes in the province of Ontario alone are considered susceptible to increased acid levels (Glass et al., 1979; Ontario Ministry of the Environment, 1980). Some lakes are naturally acid; the increase in acidity of these lakes probably has not greatly affected the aquatic life (Patrick et al., 1981). Fish caught in acid waters in the United States, Canada, and Sweden show higher concentrations of metals (principally mercury) than fish taken from nonacid waters (CEQ, 1981; U.S.-Canada Memorandum of Intent, 1981).

Available information suggests that the most likely source of increased river and lake acidity over a relatively large geographic area such as New England and southeastern Canada is atmospheric deposition of acid material through both dry and wet processes. The increased acidity of a significant number of lakes in eastern Canada appears to be a recent response to continuing acid deposition (U.S.-Canada Memorandum of Intent, 1981).

FIGURE 3.9.4 Areas Containing Lakes That Are Sensitive to Acid Precipitation



SOURCE: Galloway and Cowling, 1978. Courtesy of the Air Pollution Control Association.

Acid precipitation has been observed over a large portion of the eastern United States for the past 25 years (AER, 1981a; Cogbill and Likens, 1974). Several investigations have concluded that the acidity of precipitation has been increasing over this region during the past 25 years (Likens et al., 1976; Cogbill and Likens, 1974); however, these findings have been challenged by others, including the utility industry (Perhac, 1980). There is greater agreement that acid precipitation continues to be observed over the region.

The positively and negatively charged species most often found in precipitation over the eastern half of the United States are the ionic components of sulfuric acid and nitric acid. An examination of annual average pH values indicates that the most acidic precipitation (pH of 4.1 or lower) occurs in the New York-New England area (Likens et al., 1979); however, another study suggests that there is little variation in the amounts of sulfates and nitrates deposited by precipitation from Illinois to New York (AER, 1981a). A comparison of average sulfate and nitrate ion concentrations in precipitation in Florida between 1955-1956 and 1978-1979 indicated that there had been almost a twofold increase in the average sulfate ion concentration and more than a fourfold increase in the average nitrate ion concentration (Brezonik et al., 1980).

Acid precipitation is also of increasing concern in the western United States. Preliminary results from one investigation in Colorado suggest that precipitation with a pH of 4.6 may not be infrequent and may be caused largely by the presence of nitric acid (Lewis and Grant, 1980).

Although pH is an indication of acidity, the chemical composition of precipitation must be known to characterize the source of the acidity. Examination of the constituents of precipitation measured over the eastern half of the United States indicates that sulfate ions are about twice as common as nitrate ions (AER, 1981b).

The concentration of sulfate in precipitation over the eastern United States tends to show a seasonal maximum in the summer, similar to the seasonal maximum of air concentrations of sulfate. The concentration of nitrate in precipitation over the same area does not show any pronounced seasonal maximum (AER, 1981b).

Analyses of the chemical composition of acid precipitation over the eastern United States indicate the dominance of ions found in sulfuric acid and nitric acid; preliminary analyses of acid precipitation in the western United States suggest the dominance of ions found in nitric acid. The precursors to the formation of sulfuric acid and nitric acid in the atmosphere are sulfur oxides (mostly as sulfur dioxide) and nitrogen oxides. Chemical transformations of gaseous sulfur dioxide to particulate sulfate and of gaseous nitrogen oxides to gaseous nitric acid and particulate nitrate are influenced by atmospheric conditions and are enhanced by certain catalysts (e.g., vanadium, iron, manganese), and the presence of other pollutants such as ozone and reactive hydrocarbons.

VISIBILITY

Visibility may be reduced by the scattering and the absorption of light by gases and particles in the atmosphere. The scattering of light by fine particles with approximate diameters of 0.1 micron to 1.0 micron is probably the single most important cause of visual range reduction (EPA, 1980a). Light absorption by nitrogen dioxide and particulate matter also may be important contributors to the reduction of visual range in some locations.

In addition to contributing to acid deposition, sulfates (which exist in the atmosphere primarily as fine particles) contribute appreciably to visibility impairment. This is especially true in the eastern half of the United States and in nonurban areas of the Southwest, where sulfates are often the most common species. Atmospheric moisture, especially when the relative humidity is more than 70 percent, can have a significant impact on visibility in the presence of fine particles (AER, 1981c).

The degree of visibility impairment depends on the season, the geographic region, and the density of local sources of visibility-impairing emissions. The greatest reductions in visibility in the past 25 years appear to have taken place in the rural and suburban areas of the Northeast and nonurban areas of the Southwest (AER, 1981c).

Because visibility in the Southwest is generally very good (annual median visibilities are more than 100 kilometers at suburban and nonurban locations, compared to annual median visibilities of roughly 15 kilometers to 20 kilometers at similar locations in the Northeast), visibility impairment in that region has caused considerable concern. Regional visibility-reducing aerosols in the Southwest are generally composed of particles with mean diameters between 0.2 microns and 0.5 microns. Sulfate compounds are probably the principal constituents of the fine particulate mass, with organic carbon and silicon dioxide probably the next largest contributors (Macias et al., 1980). The role of nitrates in regional visibility impairment is uncertain, but nitrates appear to be important in determining visibility levels in urban areas such as Phoenix, Arizona, and Salt Lake City, Utah (Trijonis, 1979).

Fine particles in the Southwest are most likely the result of emissions from powerplants, smelters, automobiles, and urban areas. Windblown soil and fugitive dust emissions from agriculture, mining, and construction activities also contribute (AER, 1981c). Elevated particulate concentrations in the region are probably caused, at different times, by long-range transport (sources may be as distant as 800 kilometers), soil-derived elements from fugitive dusts, and occasional wildfires (Blumenthal et al., 1980). One investigation has suggested that relatively high lead concentrations in the region may originate in Southern California (Hering et al., 1980).

Visibility reduction in the Northeast is strongly linked to regional episodes of high sulfate concentrations, especially during the summer (AER, 1981c). An analysis of visibility data recorded at LaGuardia Airport in New York City noted that a dramatic improvement in median annual visibility (from about 9 miles to 15 miles) began in 1968 after local controls on sulfur emissions were implemented (Leaderer and Stolwijk, 1980). The improved median annual visibility appears to be due mainly to improvements in winter visibility and to only small improvements, if any, in summer visibility (AER, 1981c).

UTILITY CONTRIBUTION TO POLLUTANT LOADINGS

As noted earlier, 65 percent of the sulfur dioxide and 30 percent of the nitrogen oxides emitted in the United States come from electric utilities (EPA 1980b). Older coal-fired powerplants emit 5 to 7 times the amount of sulfur dioxide permitted to new, well-controlled facilities. In some cases, these emissions are released from tall stacks, increasing the likelihood of long-range transport.

Recent projections suggest that future emissions of nitrogen oxides, especially from stationary sources, are likely to increase while emissions of sulfur dioxide remain almost the same, so that nitric acid may be a more significant constituent of acid precipitation in the future and control of nitrogen oxides probably will remain important (ICF, 1981; TRI, 1980b). Nitrogen oxides emissions from existing stationary sources generally are not regulated under current state implementation plans. In the Ohio River Valley, where there are many coal-fired powerplants, there are virtually no emission control requirements for existing sources of nitrogen oxides. This is because most areas are not designated nonattainment for this pollutant (PEDCo, 1980).

Because powerplant emissions represent such a large proportion of total sulfur dioxide and nitrogen oxide emissions, they have increasingly become the focus of studies examining air quality impacts attributable to long-range transport. The Environmental Protection Agency and the Department of Energy (DOE) have jointly sponsored two studies to project total emissions of sulfur dioxide and nitrogen oxides from powerplants in the years 1980, 1985, 1990, and 2000. Final results from these studies are expected to be available by mid-1981; a significant number of preliminary results are already available. Although these results have not been officially endorsed by EPA or DOE, they provide an estimate of possible emission reductions, costs, and coal market impacts under a number of different control assumptions.

The studies use models to project future energy use, by fuel type, for the electric utility industry and the resulting increases or decreases in total sulfur dioxide emissions. The models also project costs associated with relative degrees of control. One model consists of a data base that includes all powerplants in the United States, which is scaled up to future demand by simulating plant additions (TRI, 1980b). The other model uses hypothetical units that represent types of powerplants, which behave according to constraints and economic options inherent in the model (ICF, 1981).

While both studies examine total loadings in the entire United States, they also focus on a 31-state region that is thought to contribute significantly to loadings in the East and Northeast and is suspected of having the greatest effect on acid rain. This region includes Arkansas, Iowa, Louisiana, Minnesota, Missouri, and all states east of the Mississippi.

In the 31 states of the eastern United States, the amount of sulfur dioxide emissions from all utilities in 1980 is estimated to be 17.7 million tons (TRI, 1980b). The total amount of nitrogen oxide emissions from all utilities in this region is approximately 4.4 million tons.

The studies sponsored by EPA and DOE are designed to examine, among other things, the possible reductions in emissions that would come from compliance with emission limits contained in applicable state implementation plans. The Commission was unable to determine the specific state implementation plan limits that were included in the analysis.

Many powerplants in the eastern United States exceed sulfur dioxide emissions limits currently allowed under state implementation plans. Precise estimates of actual emissions are impossible, but one study indicates that in 1985 emissions of sulfur dioxide from the plants will be approximately 17.5 million tons if there is no improvement in powerplant compliance with existing state emissions limits (TRI, 1980b). Results of two studies suggest that 16.2 million to 17.0 million tons of sulfur dioxide will be emitted in 1985 if plants comply with emissions limits currently in effect (TRI, 1980b; ICF, 1981). The estimated reductions resulting from compliance with existing limitations represent a 4 percent to 8.5 percent decrease in powerplant emissions of sulfur dioxide.

Over the past year, relaxations of emission limits for sulfur dioxide have been approved for nine coal-fired plants in Illinois, Michigan, Missouri, Ohio, and West Virginia. The relaxations will increase total allowable annual emissions of sulfur dioxide from these plants by 0.8 million tons per year. The effect of the relaxations on actual emissions levels is difficult to estimate because of the lack of reliable data on actual emissions from affected sources (Hambright, 1980).

Additional relaxations of existing sulfur dioxide limits are pending for approximately 18 coal-fired powerplants in Illinois, Indiana, Michigan, Ohio, Tennessee, and West Virginia. If approved, these relaxations would increase total allowable sulfur dioxide emissions by 1.5 million tons per year. The increase in actual emissions levels would be less because some of these plants are currently emitting levels of sulfur dioxide that reflect the relaxed limits. The State of New York has recently petitioned EPA to disapprove these proposed relaxations (Petition of the State of New York for Disapproval of Proposed Revision of State Implementation Plan and Comments, January 16, 1981). If these relaxations are approved, it is unlikely that any significant reduction in sulfur dioxide emissions from powerplants would result from compliance with current emission limitations in state implementation plans. In addition, conversion of powerplants to coal would also increase total sulfur dioxide loadings, although not by the same amount as the relaxation of state implementation plans (DOE, 1981).

A number of oil-burning powerplants may convert to coal in the 1980s. These plants are located primarily in Connecticut, Massachusetts, New Jersey, and New York. The increase in total sulfur dioxide emissions as a result of these conversions cannot be estimated precisely at this time because state emission limits have not been established for the converted powerplants, and because it is expected that some powerplants not currently well-controlled will be retired.

Recent Department of Energy estimates indicate that current sulfur dioxide emissions from the approximately 40 oil-fired powerplants in 10 northeastern states are approximately 30,000 tons per year. If these plants are converted to coal, sulfur dioxide emissions would increase by approximately 178,000 tons per year under current state regulations for coal-fired powerplants. If a limit of 1.2 pounds of sulfur dioxide per million Btu is required in lieu of state implementation plan requirements, sulfur dioxide emissions would increase by only 53,000 tons per year. If limits are established as recently proposed by a number of utility representatives, sulfur dioxide emissions would increase by 290,000 tons per year (DOE, 1981).

Emissions of nitrogen oxides from powerplants in the eastern United States are expected to increase from approximately 4.4 million tons per year in 1980 to 5.4 million tons per year by 1990 (TRI, 1980b).

According to preliminary results from two studies, requiring each powerplant unit to meet an emissions limit for sulfur dioxide of at most 4 pounds per million Btu would reduce total sulfur dioxide emissions from powerplants in the eastern United States from 1980 levels of 17.7 million tons to between 14.4 million and 15.2 million tons per year by 1985. This represents a reduction of between 2.5 million and 3.3 million tons per year (or between 14.1 percent and 18.6 percent) (TRI, 1980b; ICF, 1981).

Requiring each powerplant unit to meet a sulfur dioxide limit of at most 2 pounds per million Btu would reduce total sulfur dioxide emissions from powerplants in the eastern United States to between 10.1 million and 11.2 million tons per year by 1990. This represents a reduction from 1980 levels of between 6.2 million and 7.6 million tons per year (or between 35 percent and 43 percent) (TRI, 1980b; ICF, 1981).

One study has provided preliminary estimates of costs that would be incurred in addition to those required to meet current emissions limits if all coal-fired powerplants in the 31 states east of the Mississippi River were to comply with a 4-pound or 2-pound per million Btu limit for sulfur dioxide. These estimates are:

- To comply with a 4 pounds per million Btu limit, an additional $0.3 billion per year would be necessary by 1985, and $0.7 billion per year by 1990. This would result in an increase of 0.6 percent in average utility rates in the eastern United States in 1990, with preliminary estimates that utility rates could rise by as much as 3.5 percent in Missouri and 2.5 percent in parts of Ohio and Indiana.

- To comply with a 2 pounds per million Btu limit, an additional $2.2 billion per year would be necessary by 1990. This would result in an increase of 1.8 percent in average utility rates in the eastern United States in 1990, with preliminary estimates of a possible 6 percent to 7 percent increase in parts of Ohio, Kentucky, and Tennessee (ICF, 1981).

Under a 4-pound limit, the demand for high-sulfur coal from the Midwest and northern Appalachia would be less than under current emission limits; under a 2-pound limit, the demand would be even lower. Conversely, there would be a greater demand for lower sulfur coal from central Appalachia under a 4-pound or 2-pound limit than under existing limits. Preliminary results from one study, which assumed that no special actions were taken to protect local coal interests, are presented in Table 3.9.2.

Approximately 68 powerplants, located primarily in Illinois, Indiana, Kentucky, Ohio, and West Virginia would be affected by a 4 pounds per million Btu limit. A 2-pound limit would affect about 38 additional plants located primarily in Kentucky, New York, Ohio, Pennsylvania, and West Virginia, and an undetermined number of plants in other states.

The studies also examined several alternative control strategies that could be used to reduce total sulfur dioxide and nitrogen oxide emissions in the eastern United States. These strategies include coal washing, dispatching electricity from power grids in a manner resulting in lowest emissions, and specific percentage reductions in total emissions. The emission reductions potential and economic consequences of each of these will be fully discussed in the final reports for these studies, which are scheduled to be completed in mid-1981.

The current Act contains a number of institutional impediments that prevent adequate focus on the effects of long-range transport. In addition to the approaches examined in the studies conducted by EPA and the Department of Energy, a

TABLE 3.9.2 Effect of Alternative Emission Limits on 1985 and 1990 Coal Production

Coal Production (Million tons)	State Implementation Plan	4-lb limit	2-lb limit
1985			
Northern Appalachia	190	181	186
Midwest	148	132	100
Central Appalachia	262	276	280
1990			
Northern Appalachia	209	206	186
Midwest	174	156	130
Central Appalachia	318	322	352

SOURCE: ICF, 1981.

Commission study identified other means to address long-range transport. These include targeted retrofit of the largest sources of sulfur dioxide emissions, increased consideration of regional effects in the state implementation plan process, establishment of regional organizations to address multistate air quality effects, and provision of retirement incentives for older powerplants that are large sources of emissions (ELI, 1981).

CANADIAN ACTIONS

Canada has recently adopted legislation empowering its Department of the Environment to adopt comprehensive measures to reduce sulfur dioxide and nitrogen oxides emissions, according to officials of the Department. Under this legislation, an emissions limit of 2,500 tons per day of sulfur dioxide has been placed on Canada's largest smelter, requiring it to limit production but not to adopt additional emission controls. The limit will be reduced to 1,950 tons per day in 1982, requiring the smelter to adopt additional emission controls. The Department of the Environment has also secured an agreement with the major Ontario utility to reduce its total sulfur dioxide emissions from current levels of 500,000 tons per year to 390,000 tons per year in 1985 and to 260,000 tons per year in 1990, and to reduce its nitrogen oxides emissions from current levels of 80,000 tons per year to 60,000 tons per year in 1985 and to 40,000 tons per year in 1990. The Department of the Environment is studying additional possible measures under the new legislation.

SUMMARY

Air quality impacts attributable in part to long-range transport involve a variety of primary and secondary pollutants: hydrocarbons and nitrogen oxides, which contribute to the formation of ozone; sulfur dioxide, which can be transformed into particulate sulfate; and nitrogen oxides, which can be transformed into nitric acid and particulate nitrates. The principal sources of these pollutants are manmade. The conditions conducive to the formation and long-range transport of these pollutants are reasonably well known; however, the relationship between emissions from a particular source or source area and specific air quality impacts (e.g., acid deposition) in a particular area remains speculative.

Acid deposition is especially complex because of the relatively poor understanding of the complex physical processes involved and the large area over which acid deposition occurs. Similarly, visibility impairment, particularly in the eastern United States, appears to be a regional phenomenon.

The pollution control programs developed under the Clean Air Act do not directly address the air quality impacts caused by long-range pollutant transport. Several control programs under the Act do, however, reduce the amount of pollutants available for long-range transport and associated air quality effects; these are the nonattainment, prevention of significant deterioration, motor vehicle emissions control, and new source performance standards programs.

Although a direct link between reductions in emissions of sulfur dioxide and nitrogen oxides from manmade sources and reductions in adverse regional air quality impacts cannot be established conclusively at this time, available information suggests that reductions in sulfur dioxide and nitrogen oxides and in the amounts of compounds that enhance the transformation of these precursor pollutants would result in a lessening of acid deposition, an improvement in visibility, and reductions in the levels of fine particles that are hazardous when inhaled.

Substantial reductions in sulfur dioxide emissions can be achieved from additional controls on coal-fired powerplants. Preliminary information indicates that such reductions can be achieved at reasonable cost. Additional information will be available in the near future; it will provide better estimates of the economic effects of additional controls.

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CHAPTER 1: ECONOMIC CONSIDERATIONS

Since the inception of governmental efforts to control air pollution, Congress and the public have realized that there would be significant economic consequences to these efforts. Reducing air pollution would reduce the costs of health care and damages to soils, water, crops, wildlife, materials, visibility, and valued objects, but it also would require significant expenditures to be made for controlling mobile and stationary sources of pollution. Accordingly, federal laws addressing air pollution problems have reflected the judgment of Congress that an appropriate balance be made between the need to protect against the effects of air pollution and the costs and other economic effects of the protection.

Congress approached the consideration of economic effects under the Clean Air Act in two ways. For several major elements of the federal air pollution control program, such as requiring achievement of ambient air quality standards by fixed deadlines, Congress itself determined that the economic effects of any necessary control activities are acceptable and, therefore, no explicit consideration of economics by EPA in establishing standards is necessary. For other major programs under the Act, Congress required explicit consideration of economic effects. For new stationary sources, for example economic considerations have resulted in best possible pollution controls generally not being required.

While acknowledging that there has been some consideration of economic factors in determining air pollution control requirements, many critics of the Act, particularly industries subject to control requirements, have contended that the benefits of air pollution control often do not justify the economic consequences and that costs and benefits have not always been appropriately balanced. Accordingly, proposals have been made for closer examination of the relative costs and benefits of all or parts of the Act's programs and for the requirement that specific techniques be used in evaluating costs and benefits.

Studies performed to date regarding costs and benefits of air pollution control programs do not provide unequivocal conclusions. However, they do permit certain observations:

- Both costs and benefits of the Act's programs have been significant.
- Quantification of all costs and benefits of any air pollution control program is virtually impossible.
- Necessary data to make reasonably accurate cost and benefit comparisons are not likely to be available in the forseeable future because a number of relevant variables cannot be easily measured.

Recognition of national economic problems and of the costs of further pollution controls has focussed attention on the potential for incorporating economic incentives and approaches into federal clean air laws and programs. These include such concepts as the bubble policy, emission banking, emissions fees, and tax incentives.

This chapter presents the economic effects of air pollution control requirements as reflected in a number of major economic indicators. The results of recent studies regarding estimates of the aggregate costs and benefits of air pollution control requirements and the limitations inherent in these estimates are discussed. The results of studies undertaken by the Commission and others of the economic consequences of the Act's programs, including the provisions of the Act that currently require consideration of economic factors, are presented. Economic incentives approaches used in the United States and elsewhere to maximize efficiency in meeting pollution control objectives also are analyzed.

COSTS AND BENEFITS: THE NATIONAL EFFECTS

The direct and indirect costs and benefits resulting from the Act occur throughout the national economy, individual industries, and private households. Although environmental and other government regulations frequently are cited as major factors affecting the pace and direction of economic growth, effects of those regulations, including costs and benefits resulting specifically from air pollution control, are extremely difficult to measure accurately.

Although the economic effects of all pollution control--including air pollution control--on national economic indicators such as the gross national product (GNP), consumer price index (CPI), and labor productivity have not been substantial, they nonetheless represent a significant commitment of resources. Estimates of economic effects are based on data for pollution abatement investments and expenditures after subtracting control costs that would have been incurred regardless of federal regulations. However, the significance of these data for air pollution control is limited because they also include estimated effects from water pollution and solid waste regulations.

The effect of all pollution control on productivity has been an annual average decline of 0.05 of 1 percent between 1967 and 1969; 0.1 of 1 percent between 1969 and 1973; 0.25 of 1 percent from 1973 to 1975 (Denison, 1978); and 0.08 of 1 percent from 1975 to 1978. This latest statistic indicates that gradually less capital and labor are being invested in pollution control (Denison, 1979).

Productivity and real GNP have fallen and the CPI has risen as a consequence of pollution control, while unemployment has decreased. Labor productivity between 1970 and 1986 is estimated to be declining at an average yearly rate of 0.1 percent while unemployment is decreasing at the rate of 0.25 percent. Consumer prices are estimated to be rising 0.2 percent per year for the period. Pollution abatement investments contributed to inflation in two ways: increased cost per unit of goods and higher per unit labor costs and thus higher prices (DRI, 1979).

Charting the effect of pollution control requirements on future national economic growth is difficult because of inadequate or unavailable data. In particular, it is difficult to determine the extent to which facilities will or will not be constructed or curtailed solely because of air pollution control requirements. A more productive and informative means to assess the economic effects of control is to examine them on a smaller scale, such as by individual industry.

COSTS OF AIR POLLUTION CONTROL

Estimates of air pollution control costs are best expressed as a range of probable expenditures. Although in the aggregate these expenditures represent large absolute amounts, they do not result in a substantial adverse effect nationwide.

However, this does not mean that the effect on particular industries or firms may not be significant.

The total annual costs for air pollution controls for 1978, including operation and maintenance expenditures, are estimated to have been $16.6 billion. Of this amount, $7.5 billion was for capital expenditures and $9.1 billion was for operation and maintenance expenditures. The total annual costs for 1987 are projected to be $37.4 billion (1978 dollars) (CEQ, 1979).

Estimates of the costs of capital expenditures related to air pollution control for 1978 range from $1.8 billion (Rutledge and Trevashan, 1980) to $7.5 billion (Rutledge and O'Connor, 1979). This range represents what industry spent for only air pollution control on an annualized basis. Estimates of 1978 capital expenditures that have not been annualized range between $3.6 billion (Rutledge and O'Connor, 1979) and $3.8 billion (Spears, 1981).

In 1978, all industries spent an average of approximately 2.38 percent of total capital expenditures on air pollution control. The steel industry incurred the highest expenditure--11.06 percent of all building and plant costs. The lowest was incurred by the railroad industry, which expended 0.19 percent of total plant and equipment costs (Rutledge and O'Connor, 1979).

Estimates of nonannualized expenditures for air pollution control in 1979 range from $3.9 billion (Rutledge and O'Connor, 1979) to $4.4 billion (McGraw-Hill, 1980). Total industry expenditures for 1979 for air pollution control were projected to be 2.3 percent of all plant and equipment expenditures. Again, the steel industry experienced the highest percentage of air pollution control costs--11.93 percent (Rutledge and O'Connor, 1979).

The size of operations, local conditions, and the nature of production and pollution control systems make costs vary around the country, by industry, and even within industries. The Bureau of Economic Analysis Survey (Rutledge and O'Connor, 1979) reports that the highest cost ($2 billion) in 1978 was incurred by the manufacturing sector, which included primary metals, petroleum refining, and all other manufacturing processes. Public utilities followed, with $1.4 billion.

Capital costs present one of the best available indicators of the costs of clean air, although they are by no means comprehensive. Air pollution control also imposes indirect costs, but these costs are much more elusive. Indirect costs include the loss of income that is diverted from production and spent on air pollution control, costs associated with recordkeeping and regulation requirements, and expenditures for operation and maintenance of control facilities and equipment.

Further difficulties in estimating national or industry costs are caused by the lack of uniformity in methods of determining costs. Although the estimates reported here are generally comparable, adjustments have been made so that they account for the same economic variables. The variables are the effects of depreciation and amortization; extrapolation of air pollution control costs from other control expenditures through similar techniques; separating incremental air pollution control costs from normal production costs; separating air pollution control costs from pollution costs that would have been incurred without the Act; and estimating the usual discrepancy between actual and projected costs.

BENEFITS OF AIR POLLUTION CONTROL

The economic benefits of pollution control are neither readily defined nor easily quantified. Often, benefits accrue in noneconomic terms and must be converted into monetary values. Because of the uncertainties associated with data and the conversion of effects to monetary values, benefit estimates are best reported as approximations and ranges, instead of absolute numbers.

The range of economic benefits for air pollution control reported in one study is from $4.6 billion to $51.2 billion (Freeman, 1979). The reported estimates are based on studies performed by Lave and Seskin (1977), Waddell (1974), Lui and Yu (1976), Small (1977), Crocker et al. (1979), and Heintz, Hershaft, and Horak (1976), which were adjusted on a consistent basis to make them comparable. This range includes improvements to human health, reduced soiling and cleaning costs for households, reduced damages to vegetation and crops, and reduced damage to materials. These estimates do not attempt to qualify for aesthetic benefits or savings gained by avoiding pollution damage.

Eighty percent of the benefits in this range are attributable to health improvements--that is, fewer illnesses and premature deaths. The basic assumption for the overall range of benefits reported in Freeman's study is a 20 percent reduction in two criteria pollutants--total suspended particulates and sulfur dioxide. The reductions are estimated by Freeman for 1970 to 1977 for particulates and for 1972 to 1977 for sulfur dioxide. Freeman used EPA's "National Air Quality and Emissions Trends" reports for estimating the average reduction Other estimates assume greater reductions for these pollutants (Freeman, 1979).

HEALTH BENEFITS

Health benefits alone comprise the majority of total benefits estimated from air pollution control. The range of probable values of health benefits can be seen in the amounts reported in several studies. One study reported annual national benefits to be $16 billion for a 60 percent reduction in air pollutants in urban areas with a total population of 150 million. For purposes of quantification, an individual life was assigned a value of $1 million in this study (Crocker et al., 1979).

A different estimate that considered worker productivity, that is, the effects of reduced absenteeism and illness, produced yearly national health benefits of $43 billion (Crocker et al., 1979). For studies that took into account socioeconomic and lifestyle factors, such as diet and smoking, health benefits varied from $3 billion to $40 billion annually for a 20 percent reduction of air pollution levels between 1970 and 1978 (Freeman, 1979). For studies using factors such as medical costs, loss of earnings due to illness, costs of temporary household help required during illness, and other, less significant costs, the range of annual health benefits is between $3 billion and $43 billion.

NONHEALTH BENEFITS

Benefits can also be measured as gains from avoiding expenses caused by pollution. Benefits from costs avoided result from reduced pollution affecting vegetation, commercial crops, and materials exposed to the air. To obtain estimates of these avoided costs, the Commission undertook a study of nonhealth benefits. The results of the study for damage to crops and materials are reported below.

Improved Crop Production

The study found the approximate value of reduced damage to 19 food and fiber commercial crops from meeting secondary air quality standards in 1978 to be $1.78 billion (1980 dollars); the total market value of these crops in 1978 was $54 billion (1980 dollars). This estimate represents the effect on these crops of lowering levels of sulfur dioxide and ozone throughout the country. It does not include the value of reduced damage to other crops or to timber and ornamental plants (SRI, 1981).

Of the crops examined in the study, ozone causes 98 percent of the reported damage. Generally, crops suffer slightly more from short-term ozone exposure than from multiday exposure. (See Tables 4.1.1 and 4.1.2.) The states hardest hit by pollution crop damage are Ohio, Indiana, Illinois, Michigan, and Wisconsin. This region reports approximately 41 percent ($731 million) of all crop damage. The Pacific Region (Washington, Oregon, California, Alaska, and Hawaii) is the next most affected, with $384 million in pollution damages or about 22 percent of all crop damage. Crops in the Mountain Region (Montana, Idaho, Nevada, Wyoming, Utah, Colorado, Arizona, and New Mexico) are least affected by pollution damage (see Table 4.1.3) (SRI, 1981).

TABLE 4.1.1 Summary of Benefits of Agricultural Crops by Pollutant (in Millions of 1980 Dollars)

	Acute	Chronic	Total
Oxidant	$959	$788	$1,747
Sulfur Dixoide	--	34	34
TOTAL	$959	$822	$1,781

SOURCE: SRI, 1981.

Reductions in Damages to Materials

The Commission study found the value of damage avoided by meeting secondary air quality standards for the selected metals, fabrics, building materials, rubber, and plastics to be $3.95 billion in 1978. (See Table 4.1.4.) The effects of reducing three pollutants--total suspended particulates, ozone, and sulfur dioxide--form the basis of this estimate. Reductions of sulfur dioxide and ozone, whose corrosive effects on materials cannot be separated, create the largest savings of costs avoided: $3.824 billion or almost 97 percent. Of the building materials selected, total suspended particulates damage only concrete; reducing this pollutant produces a $113 million benefit (SRI, 1981).

TABLE 4.1.2 Benefits to Agricultural Crops by Crop and Acute Versus Chronic (in Millions of 1980 Dollars)

Crop	Acute	Chronic	Totals*
Alfalfa	$ 75	$ 235	$ 311
Barley	0	--+	--
Beets	--	1	1
Broccoli	4	16	21
Cabbage	9	19	28
Corn (for grain)	332	0	332
Cotton	0	--	--
Hay	113	2	114
Irish potatoes	34	132	166
Lima beans	--	8	8
Oats	35	10	44
Sorghum	11	0	11
Soybeans	96	116	213
Spinach	1	1	1
Sweet corn	27	24	51
Tobacco	50	46	96
Tomatoes	167	208	375
Wheat	5	3	8
TOTAL	$ 959	$ 822	$1,780

*Totals may not add because of rounding.

+-- Denotes estimate between 0 and 0.5 million.

SOURCE: SRI, 1981.

Avoided damages to individual materials range from $333 per short ton of tin to $4.10 per short ton of aluminum. Nickel shows pollution damage costs avoided of $304 per short ton while the damages to plastics are estimated to be only $15 per short ton and damages to copper to be $18.90 per short ton. For rubber products, pollution particularly affects the value of medical and hose products, reducing their service life by about 50 percent (SRI, 1981).

Fabrics and clothes are most adversely affected by total suspended particulates. The benefits to individuals and households from reducing this pollutant are estimated to be savings of $535 million. The largest savings benefit, $130 million, is in the Mid-Atlantic Region (New York, Pennsylvania, and New Jersey,

TABLE 4.1.3 Summary of Benefits by Region (in Millions of 1980 Dollars)

Region	Crops	Materials	Soiling	Visibility	Total
New England	$ 51	$ 308	$ 42	$ 6	$ 407
Middle Atlantic	383	968	130	231	1,712
E. N. Central	731	874	118	112	1,835
W. N. Central	81	184	25	12	302
S. Atlantic	61	359	49	11	480
E. S. Central	60	139	19	7	225
W. S. Central	14	320	43	8	385
Mountain	12	162	22	13	209
Pacific	384	641	87	88	1,200
TOTAL	$ 1,777	$ 3,955	$ 535	$ 488	$ 6,755

SOURCE: SRI, 1981.

TABLE 4.1.4 Summary of Estimated Materials Benefits (in Millions of 1980 Dollars)

Materials	Estimated Benefits
Aluminum	$ 316
Concrete	113
Copper	131
Fibers	618
Nickel	416
Paint	421
Plastics	336
Rubber	1,053
Steel	12
Tin	534
Zinc	3
TOTAL	$3,952

SOURCE: SRI, 1981.

followed by the East North-Central Region (Wisconsin, Michigan, Illinois, Indiana, and Ohio, with $118 million (SRI, 1981). (See Table 4.1.3.)

Enhanced Property Values

In areas with high levels of motor vehicle emissions, property values tend to be lower and wages higher to compensate for the polluted surroundings. Consequently, reducing emissions results in economic benefits. Reductions in nitrogen oxides and photochemical oxidants have been estimated to create property value improvements of between $1.5 billion and $5 billion nationally and estimated wage benefits of $5 billion (NAS, 1974). (The same study estimated that when the benefits owing to reduced damage to materials, health, and vegetation from a 35 percent to 80 percent decrease in mobile source emissions are added to the benefits calculated by the property values or wage-rate differentials, a range of values from $2.5 billion to $10 billion is derived.)

Improved Visibility

Although good visibility is valued for aesthetic reasons, its value also can be estimated in terms of individuals' willingness to pay for cleaner air and improved visibility. According to national estimates derived from a survey in the western United States, the general population is willing to pay $0.5 billion for improved visibility (SRI, 1981). A study in the Four Corners region that asked individuals what they would pay to improve visibility and to live in an area with naturally clear air produced estimates of $15.5 million and $24.6 million, respectively, for the value of the two benefits (Randall et al., 1974). Residents in the Los Angeles area reported a willingness to pay $29 per month per household for a 30 percent improvement in air quality (Brookshire et al., 1979).

A study currently being conducted in the Grand Canyon region is attempting to quantify the amount people are willing to pay for air that is improved from poor to excellent quality. The study also is attempting to establish a monetary value for the existence of clear air for people who do not live in the area, based on the premise that accessible clean air and clear vistas in certain areas are perceived as valuable commodities in themselves.

LIMITATIONS OF COST AND BENEFIT ESTIMATES AND COST AND BENEFIT ANALYSES

The above discussion highlighted wide variations among estimates of costs and benefits reported in numerous studies. Any estimate of expenditures and benefits related to requirements of the Act depends upon numerous subjective variables used in its calculation. Every assumption and body of data contain limitations and qualifications that make the development of unchallengable estimates virtually impossible.

The same data, in fact, can produce contrary results. Estimates that use different assumptions for pollution reduction levels, current prices, and the monetary value of human health will arrive at different conclusions. For instance, a recent study of air quality costs and benefits analyzed data used in earlier studies, results of which are reported in this chapter. But, by making different assumptions, the later study estimated benefits as only 20 percent to 25 percent of those reported in the earlier study (National Economic Research Associates, 1980).

A report on methods for estinating costs prepared for the Commission noted a number of limitations with these estimates. These include the unavailability of complete data bases and the inexact nature of future projections (Leone and Garvin, 1981). In addition, any attempt to isolate air pollution control costs from other costs associated with environmental controls requires that judgments be made about the amount each contributes to the reported total. For example, overhead and operation and maintenance costs must be distributed among air pollution control, water pollution control, and solid waste disposal requirements. Also, different accounting considerations among firms with differing assumptions regarding interest rates, methods of depreciation, and definitions of fiscal year lead to dissimilar reporting of cost estimates.

An additional cause of variation in cost estimates is that some firms may be reluctant to fully disclose cost information for reasons of confidentiality or competition (Leone and Garvin, 1981). Projections of future costs also may be inaccurate because advances in pollution control equipment or production processes are made that were not anticipated at the time the projection was made or because expected advances do not occur. Finally, the sources that gather cost data may define industrial groupings differently, making useful comparisons difficult.

The many limitations associated with the methodology of estimating benefits were analyzed by a Commission panel. These limitations include: calculating health benefits, which entails applying and analyzing data on ambient pollution levels; correlating human health and air pollutants; and calculating the costs of morbidity and mortality. In addition, health statistics for the general population are incomplete and in some cases unavailable. Placing a monetary value on these statistics generates further problems (Benefit Methodology Evaluation Panel, 1980; Sterling Hobe Corp., 1980).

Projecting anticipated benefits to crops and materials requires predicting future production levels, future prices, and future interest rates. Each of these predictions contains considerable uncertainty. Another category of benefits, the aesthetic value of clean air, contains even greater unknowns and degrees of subjectivity. Although clean air is generally recognized as important, its monetary value eludes systematic, objective quantification. Surveys and questionnaires elicit different responses and result in different estimates. Consequently, the benefits of the Act requirements appear to be considerable, yet impossible to measure exactly.

Because of the limitations of the data and the numerous assumptions used in these studies to calculate the costs and benefits of air quality, the Commission did not make direct comparisons between the estimated costs and benefits. Both are clearly substantial, but there is no sound basis for stating that one is greater than the other.

One of the most frequently discussed proposals for consideration of economic factors under the Act is cost-benefit analysis. This analytical technique provides a means of government regulations and other actions. Recognizing that government discussions often require a reconciliation of competing interests, cost-benefit analysis seeks to quantify and compare costs and benefits of the proposed actions to maximize the efficency in monetary terms.

The discussion of benefit estimations, above, describes some of the difficulties faced in accurately quantifying both costs and benefits. In addition to the difficulties of quantification, other more fundamental issues arise if cost-benefit analysis is proposed to be used in evaluating the goals of the Act, or in establishing health-based standards.

A major limitation is that cost-benefit analysis only addresses economic efficiency. Although it provides the best approach for comparing costs and benefits in monetary terms, it generally does not allow adequate consideration of benefits such as life and health, which are not susceptible to valuation in those terms. If a value is determined by one's willingness to pay, each individual's preference is weighted by the person's relative wealth, that is, by the number of dollars he or she is able to put on that preference. Finally, reliance on the present market to measure the value of longer-term benefits (e.g., illness avoided) discounts the value of these benefits in the future.

Finally, use of cost-benefit analysis in establishing national health-based standards could result in standards being established at levels that could be justified for areas of the country with the most severe pollution problems where the cost of controls would be greatest. For example, Los Angeles may not be able to meet the current ozone air quality standard without imposing measures that would cause severe economic disruption. If such costs are included in establishing a national standard, the cost portion of the cost-benefit analysis would be increased and could lead to establishment of a national standard that would be acceptable in less severely effected areas. These areas, therefore, could have substantially greater levels of air pollution than would have been allowed if a regional cost-benefit analysis had been performed.

Thus, while cost-benefit analysis may be useful in evaluating certain decisions, its utility is severely limited as a means of establishing a national health-based air quality standard.

ECONOMIC EFFECTS OF STATIONARY AND MOBILE SOURCE CONTROLS

This section discusses the economic effects of programs under the Act to control of air pollution from stationary and mobile sources. The programs are prevention of significant deterioration, nonattainment, new source performance standards, federal motor vehicle control, and inspection and maintenance. The economic effects on local industries, regional employment, and regional growth are emphasized as more data are available on those bases.

The difficulties in quantifying the national benefits of the Clean Air Act have been discussed above. The Commission's benefits panel concluded that an attempt to disaggregate these estimates to determine benefits by specific regions and programs would be an extremely difficult task and one that it did not have adequate resources to undertake (Benefit Methodology Evaluation Panel, 1980). Only one study is available that has quantified benefits for a specific control program under the Act--the federal motor vehicle control program (NAS, 1974). Thus, estimates of monetary benefits associated with air quality programs are not discussed in the following text.

The Commission examined economic effects in five areas: New York metropolitan-Connecticut; Twin Cities-St. Cloud; Ohio River Valley (portions of Kentucky, Ohio, and Indiana); Southern California (Los Angeles area); and Four Corners (portions of Colorado, Utah, Arizona, and New Mexico). In the first four regions, the control requirements were based primarily on the requirements of the nonattainment program, and the economic effects examined were those due to control requirements on existing firms. In the Ohio River Valley, however, costs to new firms locating both in areas attaining and in areas exceeding national air quality standards were also taken into account. In the Four Corners region, all costs were attributed to the effects of new source review under the prevention of significant deterioration program.

In these regions, not all pollutants were examined; thus, in some cases certain control measures were not included in the analysis. However, with the exception of particulate controls in Los Angeles, no controls having significant potential economic effects for stationary sources were excluded.

EFFECTS ON REGIONAL OUTPUT, EARNINGS, AND EMPLOYMENT

Commission studies found that the pollution control measures required under the 1977 Amendments will have minor, but somewhat negative, overall effects on regional economies. Reductions in output and earnings generally will not be significant in comparison to total regional output.

The New York metropolitan and Ohio River Valley areas are good examples of established industrial regions with large industrial bases that also are experiencing substantial air pollution problems. In the New York metropolitan region, where the pollutant of most concern is ozone, the controls imposed by 1979 state implementation plans for New York, New Jersey, and Connecticut are primarily controls on existing sources of hydrocarbon emissions. The imposition of these measures is projected to decrease yearly regional gross output by approximately $8.9 million and earnings by approximately $1.4 million. By comparison, the total gross regional output was $172.3 billion in 1975 (Temple, Barker, and Sloane, Inc., 1980).

In the Ohio River Valley, 1979 state implementation plans contain measures for reducing sulfur dioxide, particulates, and hydrocarbons. (Hydrocarbon reductions are required in three major cities: Dayton, Cincinnati, and Louisville.) A more extensive variety of control measures is required, including scrubbers, electrostatic precipitators, fabric filters, mechanical collectors, surface coating systems, low-sulfur fuels, and boiler conversions. The maximum short-term effect on total output is projected to be a yearly decrease of approximately $126 million or 0.25 percent. Over a longer period (6 years), annual reductions of $653 million in regional output, or 1.27 percent, could result. The total output from leading industries in this region is in excess of $51 billion (JACA, 1980).

Compliance with implementation plan requirements in the Ohio River Valley is estimated to result in, at most, a reduction of 0.25 percent per year in regional employment in the long run. Income is projected to fall by 0.27 percent per year (JACA, 1980).

In both New York and the Ohio River Valley, substantial positive one-time injections into the economy are provided by pollution-control-related industries. In the New York region, an increase in regional output of up to $371 million might be expected in each of the first 2 or 3 years (compared to the $8.9 million decrease in regional output caused by the control requirements). Thus, any decrease in regional output in the New York region in the first several years should be offset at least in part by this short-term injection (Temple, Barker, and Sloane, Inc., 1980). In the Ohio River Valley, output in the first 2 years can be expected to increase by about 2.8 percent and employment by 3.8 percent (JACA, 1980).

Twin Cities-St. Cloud is an example of an area in which specific sources cause the sulfur dioxide and total suspended particulates standards to be exceeded. In addition, although the area is currently not designated as nonattainment for ozone, that standard potentially may be exceeded. Because of this potentiality, the regional analysis considered costs for the implementation of all reasonably available control measures on sources of hydrocarbon emissions as well as the costs of controls for sources of sulfur dioxide and total suspended particulates. With all measures adopted, regional output over the long run declines by about $8 million per year after a short-term annual increase of $5 million for the first 2 years because of pollution control investments. This compares to a total 1980 regional output of almost $36 billion. Changes in employment are negligible (ETA, 1980b). While more recent ozone monitoring data indicate that the Twin Cities may ultimately be designated nonattainment for ozone, the Commission's study indicates that not all reasonably available controls for hydrocarbons will be required. Thus, the economic impacts will be somewhat less than those reported above (ETA, 1980c).

The Commission was unable to evaluate secondary economic effects in the Los Angeles region. In this region, many available measures providing the greatest level of control have been required because of the severe pollution problem. For the control of hydrocarbons, nitrogen oxides, and sulfur dioxide, more than $2 billion in capital costs prior to 1987 and $643 million in annual costs will be incurred by the industrial sector. Certain industries will bear a significant portion of these control costs (EEA, 1981a).

These four regions were affected primarily by the requirements of the nonattainment program; in the Four Corners area, a region likely to experience significant growth, predominantly in the utility, synthetic fuels, and other mining industries, effects of the prevention of significant deterioration program can be observed. Although costs of pollution control to these industries are large (see Table 4.1.5), the costs are not anticipated to have adverse effects on regional output. In most cases, product price increases are unlikely to affect investment or sales. Moreover, in this region, air pollution control requirements are expected to add approximately 9,000 jobs by 1995 (LASL, 1980b).

Industrial Expansion

As discussed in Part 3, Chapters 4 and 5, the nonattainment and prevention of significant deterioration programs have allowed, and are projected to allow, the location of most new or modified facilities. Commission studies also indicate that new plant sitings and industrial expansion in the areas studied have not been significantly affected by the cost of air pollution requirements in the past. In addition, the Commission's regional analyses indicate that future industrial expansion is not expected to be significantly affected. In the

TABLE 4.1.5 Costs Through 1995: Medium Energy Growth Projections (in Millions of Dollars)

Industry	Capital Costs	Annual Costs
Coal-Fired Electric Generation Plants	$ 1,858-3,500	$ 538-1,010
Coal Gasification Plants	87	64
Synthetic Fuel Facilities	506	218
Uranium Mining and Milling Activities	332	50

SOURCE: LASL, 1980b.

Four Corners region, where substantial growth in the energy industry is anticipated, the costs of air pollution controls should not create limitations on energy projects.

Plant Closures, Product Price, and Other Effects

Commission studies indicate that air pollution control requirements have not resulted in a significant number of plant closures in the past. Since 1970 in the New York region, five plant closures have been reported that were partly influenced by requirements to install pollution controls. The closures affected 245 employees (GCA, 1980a). In the Ohio River Valley, five incinerator closings in Cincinnati and seven plant closings in Louisville were attributable to air pollution control regulations. Only slight employment effects resulted because of plant relocations and transfers of employees to other operations (PEDCo, 1980b). In the Twin Cities region, air pollution requirements played a part in the closing of at least three plants (ETA, 1980a).

Commission studies, based on these regional economic analyses, project that the potential for future plant closures is slight. However, because the regional assessments are based primarily on model plant analyses, unique characteristics of specific firms and plants sometimes are not identified. Therefore, the projections in the analyses may not completely represent total effects on all firms in the region. Certain industries that require significant expenditures for pollution control or that are operating on weak financial bases, in declining periods of profitability, or with little flexibility in price elasticity may experience difficulties in raising capital needed to meet certain requirements.

The domestic steel industry, for example, may have difficulty in meeting the capital requirements necessitated by certain provisions of the Act. Aging facilities and poor capital recovery are among the factors that have left the industry in a poor competitive position with respect to foreign industries. The slow growth of the industry may be attributed partially to an increase in imports and increased use of aluminum and plastic. Because of the industry's high level of emissions, the costs of compliance have been high. In the past, nearly one half of the industry's capital spending for environmental controls has been financed through industrial development bonds and the remainder with capital investment through retained profits and equity financing. In the future, industrial development bonds, the state of the domestic economy, and the industry's ability to generate capital internally will be decisive factors in the steel industry's ability to comply with environmental regulations (OTA, 1980).

One means of assessing the effects of control requirements on specific firms is to examine the level of annualized costs that must be absorbed to comply with the requirements. The most conservative analysis assumes that all costs are absorbed and pretax profits reduced accordingly. Expenditures for control costs that are a significant percentage of the value of total output usually are indicators of potential problems. As part of its program to evaluate economic effects, EPA has established a policy that control costs in excess of 5 percent of the value of an industry's output constitutes a significant effect.

In the Ohio River Valley, only the steel and utility industries are projected to incur total control costs in excess of 5 percent of the value of their output. The size and structure of these industries make plant closures unlikely; however, some impacts on employment may occur in the steel industry.

The Commission's studies found that the effects on product price vary considerably from industry to industry. In some cases, there are relatively significant increases; in still others there are savings, and in still others there are insignificant effects. One Commission study projected the cost of steel produced in the Ohio River Valley to increase by 6.6 percent. The same study estimated that the price of producing electricity in a portion of the Ohio River Valley would increase by 25 percent if sources complied with the state implementation plan (PEDCo, 1980b). This latter estimate is based on the application of scrubbing technology to seven powerplants in the region. However, four of those plants have indicated that they plan to rely on lower sulfur coal for compliance. The estimate fails to consider factors such as the electric grid system under which electricity is produced at facilities at the lowest available cost and transmitted to distant places across states. These facilities are not in the area studied by the Commission and were not analyzed as a part of this study. Therefore, the active effect on utility rates could not be accurately estimated.

For individual firms in the New York metropolitan-Connecticut region, controls on surface coating of automobiles and light trucks have the highest potential cost, $24.4 million annually, while controls on bulk gasoline plants, fixed-roof storage tanks, and tank truck terminals have potential savings of $37.6 million annually. The range of largest product price effects (assuming all costs are ultimately borne by consumers) is from a 2.4 percent decrease to a 3.9 percent increase. If, at the other extreme, all control costs are absorbed by the firm, the largest possible reductions in pretax profit margins are about 0.3 percent (GCA, 1980c). In the Twin Cities, no significant industry effects were identified (ETA, 1980a).

Utility prices in the Four Corners area are expected to rise by 10 percent to 20 percent as a result of air pollution requirements. The effect on the financial position of the utility industry will depend heavily on ratemaking and financing rules adopted by local public utility commissions. Costs to the synthetic fuel industry are relatively uncertain because estimates range widely. Because of the potential for subsidies, the secondary effects were not estimated (LASL, 1980a).

In Los Angeles, significant expenditures are required for the chemical industry ($148 million capital, $33 million annual), the petroleum refining and gas extraction industry ($239 million capital, $106 million annual), and electric utilities industry ($1 billion capital, $396 million annual). Although these costs are large, the size and structure of the industries will allow incorporation of costs without significant effects on price, production, or profitability. For instance, petroleum and gas firms will require a 1.68 percent increase in capitalization over 7 years, and an 8 cent per barrel price increase. Utilities require a

1.4 percent per year increase in capitalization over 7 years, which would constitute a 0.3 cent per kilowatt hour increase. Annualized costs would add an 0.4 cent per kilowatt hour increase. This 0.4 cent per kilowatt hour increase is about a 7 percent increase over current utility rates. The chemical industry would require a 5 percent increase in capitalization over 7 years and a price increase of 1.5 percent.

Total costs to the steel industry in the Los Angeles area are not high in comparison to the industries just discussed, although the increase in capitalization (between 7 percent and 9 percent over 7 years) may prove to be significant in light of the competitive posture of the facility at the present time (EEA, 1980a).

The Offset Program

The Commission is unaware of any comprehensive studies describing the economic effects of the offset policy. This policy requires increases in emissions from major new and expanding sources to be offset by reductions from existing sources in amounts greater than the increase. For the most part, as noted in Part 3, Chapter 5, offset requirements have been satisfied by a company's obtaining offsets from its own existing facilities in the area. To the extent that internal offsets are obtained by the shutdown of facilities scheduled to close anyway, no costs have resulted from the offset policy. In the past, many internal offsets have been "paper" rather than actual reductions, as firms have agreed to a reduction in emissions permitted under state plans to the level a plant is actually emitting. Plants also have obtained offsets by enhancing the efficiency of existing facilities; this modernization has led to cost savings in many instances.

Only limited information is available on the cost of obtaining offsets from sources other than the expanding facility or a facility not owned by the source. One study reported two external offset cases in which offset prices were involved (Vivian and Hall, 1979). In one case, General Portland Cement planned to build a new plant in New Braunfels, Texas, that would have caused the area to exceed the standard for total suspended particulates. To avoid the cost of modelling and to ensure that the facility could locate in the area, the company asked another firm, Parker Brothers, to install dust collectors at General Portland's expense. General Portland paid $550,000 ($270,000 for equipment, $105,000 for engineering costs, and $175,000 for installation costs) for reducing 950 tons per year of particulates, at a cost of $580 per ton. The maintenance costs of the equipment, which were negligible, were borne by Parker Brothers.

In the second case, a sulfur dioxide offset for a proposed 90-megawatt refuse-burning powerplant in Columbus, Ohio, was purchased. To offset 9,000 tons of emissions per year, the city paid $410,000 ($250,000 for controls and $160,000 for increasing the stack height) to a consortium of three companies. The average price per ton per year for this transaction amounted to $45.

In another example, the Wickland Oil Company paid $250,000 to the City of Selby, California, for offset rights to construct a 40,000 barrels per day oil terminal. The city had obtained the hydrocarbon offset from a closed chemical plant. The company purchased the offset of 150 tons per year of hydrocarbons at a price of $167 per ton.

Three additional cases of offsets for which cost data were available although they did not involve purchase transactions, were reported (Vivian and Hall, 1979): To locate a Volkswagen of America plant in New Scranton, Pennsylvania, a reduction of hydrocarbon emissions was required. The State Department of Transportation reduced the asphalt content of roads by 20 percent and reduced hydrocarbon emissions by 1,411 tons. The average cost per ton of hydrocarbon was $450. A prefinished metals plant at Bowling Green, Ohio, reduced 165 tons of hydrocarbon at a cost of $30 per ton. A General Motors Corporation plant in Oklahoma City, Oklahoma, obtained offsets of hydrocarbons from four oil companies totalling 5,180 tons per year at an average cost of $30 per ton.

The future demand for offsets in nonattainment areas will require application of controls in addition to those required by the 1979 state implementation plans. With more rigorous implementation of the offset program, it is expected that more external offsets requiring payment by the new or modified source will occur, although internal offsets are likely to continue to comprise the overwhelming majority of offsets.

Estimated Effects of Additional Controls

Control requirements adopted to date are not anticipated to have significant economic effects, and in many cases these measures represent the most economically reasonable measures available to firms in the region. However, based on the information found in several Commission studies, additional control measures may be necessary to ensure attainment of ambient standards in certain instances or to address long-range transport.

The Commission studies indicate that the costs of additional controls vary. In some cases, particularly for certain measures designed to reduce volatile organic compounds, additional controls do not add substantial costs: Reductions in emissions can result from more efficient use of previously installed equipment. Further, increased recovery of volatile products, such as in fuel transfer operations or in industrial processes using expensive solvents, can lead to reduced emissions without increased costs. Other types of controls requiring additional equipment or maintenance are likely to be more expensive and less cost-effective than most controls required at present.

The installation of controls necessary to meet standards in certain areas will result in identifiable economic effects, but in most cases these effects can be absorbed into the regional economies. Only where controls involve major equipment modifications for large sources (e.g., scrubbers for utilities) are effects likely to be significant.

In New York, for example, additional volatile organic compound controls to help meet the ozone standard would decrease the regional output by $26 million annually (as compared to an $8 million decrease in output for measures currently required in the area). The cost-effectiveness of these additional measures varies by industry. For instance, the cost-effectiveness of the existing control measures for auto coating ranges between $1,287 and $1,394 per ton. More stringent measures on this category of sources would cost between $4,090 and $18,116 per ton. However, for wire, fabric, paper, and metal furniture coating, no additional costs would be incurred (GCA, 1980b).

In the Ohio River Valley region, the total long-run effect of requiring a variety of additional controls for total suspended particulates and sulfur oxides would result in an additional 0.01 percent decline in regional output beyond that projected for the current state implementation plan. The steel industry would be most affected, with a projected 3.34 percent increase in price and a 2.8 percent decrease in gross output, in addition to the 6.6 percent incease in price expected to result from the state implementation plan measures. Although overall effects on regional employment would not be significant, employment effects in the industrial and farm machinery industries would be larger than those for the steel industry because they are more labor intensive. In the Ohio River Valley, the regional effects of imposing a uniform standard of best available controls on all sources would be twice as great as those from imposing controls necessary to meet the national ambient air quality standards (JACA, 1980).

In Los Angeles, imposing additional controls, which would uniformly require best available technology, would increase capital costs of controls by 38 percent to about $3.5 billion. Again, the principal industries affected in the region would be chemical, electric utility, and petroleum refining industries, showing additional increases in capital costs of 50 percent, 25 percent, and 33 percent, respectively (EEA, 1980b).

In the Ohio River Valley and Twin Cities, estimates of the difference in cost-effectiveness of control measures representing reasonably available controls, best available control technology, and lowest achievable emission rate were compared for hydrocarbon, total suspended particulate, and sulfur dioxide emission reductions. Wide variations among control costs are apparent. As previously noted, under the reasonably available control requirements, costs vary widely for all pollutants--from large savings to large costs. The range of costs among the three levels of control also was extensive. For the most part, the measures representing best available control technology and lowest achievable emission rate levels had higher incremental costs per ton than did measures representing reasonably available controls. However, in a significant number of cases, the incremental costs of the more stringent control measures were less than those for controls considered to represent reasonably available control technology (PEDCo, 1980a; ETA, 1980c).

A Portland, Oregon study estimated demand for total suspended particulate and volatile organic compound offsets and attempted to evaluate the costs of additional emission reductions required to meet this demand (Seton, Johnson, and Odell, Inc., 1980). The supply of particulate offsets was traced to the wood products, steel, and aluminum industries; for volatile organics, it was traced to seven different industries--aluminum, asphalt storage and loading, industrial dry cleaning, wood finishing, bulk gasoline storage, metal products, and printing. The study estimated capital and operation and maintenance costs for reducing the emissions and calculated the annualized costs. The estimates of the costs in Portland were compared to those for similar control measures in the Los Angeles area as reported by the Southern California Association of Governors (SCAG, 1978). (See Table 4.1.6.) The controls in the Los Angeles air quality maintenance plan are more stringent than those in many other parts of the country and therefore represent additional controls that also may be available in other areas.

The Oregon study concluded that the annualized cost for total suspended particulates per ton was $30,000 as compared to $1,100 per ton for volatile organic compounds. There is no significant difference in volatile organic compound costs for Portland and southern California. (The small variation in cost per ton is due partially to the fact that southern California estimates are in 1978 dollars, whereas the Portland data are in 1980 dollars.) There is, however, a significant difference for annualized total suspended particulate costs caused in part by the differences in the costs of certain measures analyzed.

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OHIO RIVER BASIN ENERGY STUDY (ORBES): MAIN REPORT

by

The ORBES Core Team

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Executive Summary

1. THE ORBES PROJECT

The Ohio River Basin Energy Study (ORBES) began in the fall of 1976 in order to assess the potential environmental, social, and economic impacts of a proposed concentration of power plants in a portion of the basin. The U.S. Senate Appropriations Committee had mandated the U.S. Environmental Protection Agency (EPA) to carry out this study just after the Arab oil embargo (1973-74) in response to citizen concern. At that time several utility companies had announced plans to construct additional generating units in the Ohio River Basin.

The Ohio River region offered the electric utilities (and related industries) some of the nation's most suitable power plant sites, particularly since coalfields containing almost half of the nation's reserves by tonnage are within easy reach (see figure ES-1). Some citizens, however, questioned the necessity of adding such a large number of generating facilities, particularly near the Ohio River itself. They also pointed out that the proposed new plants would transmit much of their electricity far from the immediate area.

In an effort to identify the implications of locating future energy conversion facilities in this particular part of the Ohio River Basin, the Senate Appropriations Committee directed EPA to conduct a study "comprehensive in scope, investigating the impacts from air, water, and solid residues on the natural environment and [on the] residents of the region. The study should also take into account the availability of coal and other energy sources in the region."

2. GENERAL REGIONAL CHARACTERISTICS

The ORBES region covers 190,377 square miles in 423 counties in the states of Illinois, Indiana, Kentucky, Ohio, Pennsylvania, and West Virginia (see figure ES-2). The predominant land use in the region is agriculture, which accounts for 54 percent of regional acreage. The types of farming range from vast corn and soybean tracts in Illinois to smaller tobacco farms in Kentucky. Mixed mesophytic, northern hardwood, beech-maple, oak-hickory, and other forests cover another third of the region.

The regional river systems and aquatic life are as diverse as can be found in the United States. These regional water systems range from whitewater canoe and mountain trout streams to deep, clear lakes popular as recreational spots, major rivers both navigable and free flowing, and numerous wetlands and sloughs. These water systems support more than 250 fish species, with several of the navigable rivers containing at least 90 species and some large lakes containing over 125.

Figure ES-1
ORBES-Region Coalfields

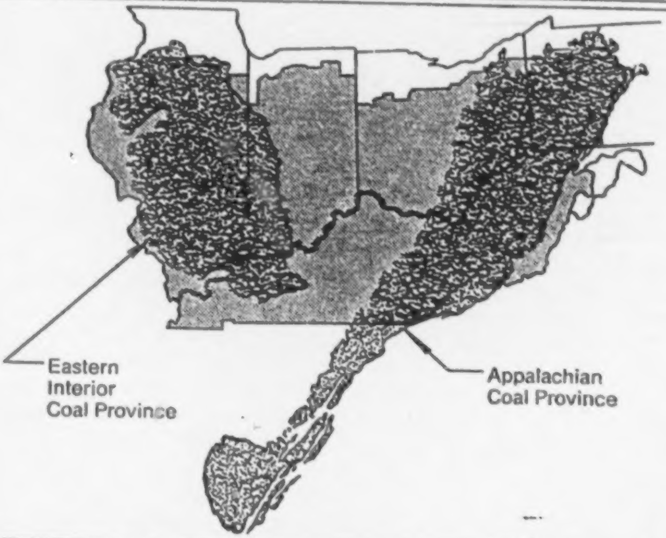
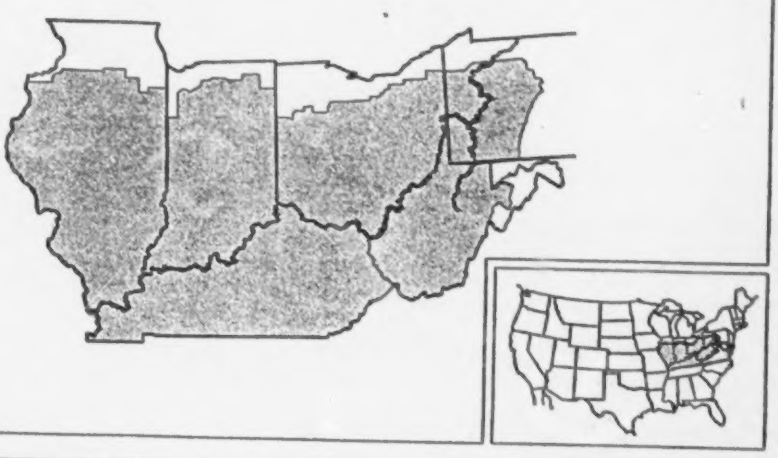

Eastern
Interior
Coal Province
Appalachian
Coal Province

Figure ES-2
Ohio River Basin Energy Study (ORBES) Region



The ORBES region contains about 11 percent of the national population and accounts for about 10 percent of the gross national product. The major economic sector in the region is manufacturing, which accounts for about 31 percent of the gross regional product, followed by trade (16 percent), government (12 percent), and finance, insurance, and real estate (11 percent). The remaining 5 sectors each accounts for less than 11 percent of the gross regional product (see figure ES-3); the coal-mining and agricultural sectors constitute 3 percent and 4 percent, respectively.

Coal is the most significant indigenous fuel in the ORBES region and accounts for two-thirds of national production. Coal also is the primary fuel used in the region. Coal use accounts for about half of the total regional fuel consumption, and the electric power industry in the region consumes about two-thirds of this coal. About 95 percent of regional electrical generating capacity is coal fired. Nonfossil fuels, in general, account for less than 1 percent of the total conventional fuel use in the region--approximately the same percentage as in the nation.

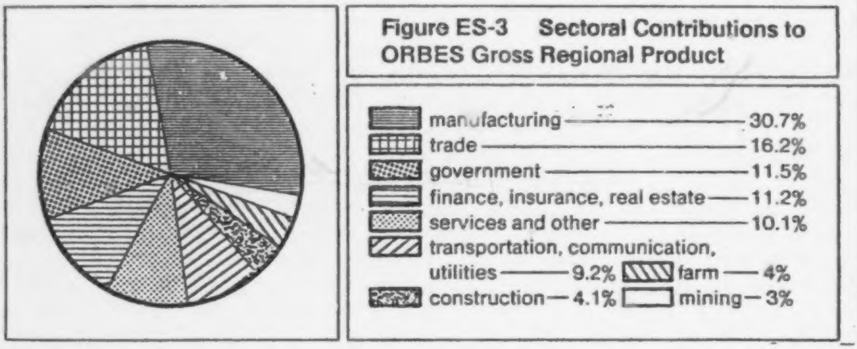


Figure ES-3 Sectoral Contributions to ORBES Gross Regional Product

3. REGIONAL AIR, WATER, AND LAND STATUS IN MID-1970s

AIR. Perhaps because of the high coal use, air quality standards for sulfur dioxide and particulates were not being met at several locations in the ORBES region during the study's base period (the mid-1970s). Several other locations were close to violation. For example, in 1977, 11 ORBES-region counties violated national ambient air quality standards (NAAQS) for sulfur dioxide, and an additional 13 counties did not have available the full prevention of significant deterioration (PSD) increment for sulfur dioxide to accommodate new sources; the ambient concentrations in these counties were at or just below the NAAQS. In the same year, 130 counties in the region violated the NAAQS for total suspended particulates (TSP), and an additional 5 counties had less than the full PSD increment available. Many of the counties that violated the TSP and sulfur dioxide NAAQS were clustered in extreme southwestern Ohio and along the Ohio-Pennsylvania-West Virginia border. However, since over 50 percent of the counties in the ORBES region are without monitoring for sulfur dioxide or TSP, the number of 1977 violations probably is underestimated.

In all probability, ORBES-region generating units contribute substantially to sulfur dioxide concentrations since they produce about 80 percent of regional sulfur dioxide emissions. In fact, in 1975, regional utility sulfur dioxide emissions constituted 52 percent of national utility sulfur dioxide emissions and 32 percent of national sulfur dioxide emissions from all sources. In contrast, during that same period, about 36 percent of the national coal-fired electrical generating capacity was located in the ORBES region.

ORBES-region utilities contributed smaller but significant shares of the 1975 regional nitrogen oxide and particulate emissions--about 47 percent of regional nitrogen oxide emissions from all sources and about 22 percent of regional particulate emissions from all sources.

However, regional data indicate that long-range transport of emissions, even over distances of several hundred kilometers, was and is an important factor in regional pollutant concentrations. At several locations throughout the region, between 30 and 50 percent of the 25 highest daily sulfur dioxide concentrations are associated with transport by extremely persistent winds. Moreover, under certain meteorological conditions, sulfur dioxide is transformed into sulfates, thereby contributing to regional sulfate concentrations. In addition, since sulfates are, by definition, the total water-soluble component in TSP, such transformation of sulfur dioxide into sulfates ultimately affects the TSP concentrations. Data from the base period confirm the importance of both sulfates and their transport in TSP concentration levels.

It is important to understand the relationship among the transport of sulfur dioxide, its transformation, and regional sulfate episodes. Sulfur dioxide concentrations of 130 micrograms per cubic meter (one-tenth of the secondary three-hour standard) in the presence of current ozone levels have been linked to vegetation damage and crop loss. Also, a growing body of evidence supports the hypothesis that the annual average exposure to sulfates--or something closely related to them--results in an increased mortality rate. In addition, sulfate episodes are correlated with acidic precipitation episodes; acidic precipitation is believed to be due primarily to the presence of sulfate and nitrate ions. Finally, sulfate episodes often are associated with the occurrence of reduced visibility over large areas.

An examination through mathematical modeling of four representative regional sulfate episodes between 1974 and 1976 reveals similarities among the episodes. In general, sulfur dioxide emissions in the lower ORBES region contributed significantly (between 50 and 90 percent) to the sulfate concentrations in the upper region. Moreover, of the sulfate concentrations in the upper region attributable to emissions in the lower region, utility sulfur dioxide emissions in the lower region contributed at least half; in at least two of the four episodes, these emissions contributed over 90 percent. (The lower ORBES region consists of the ORBES state portions of Illinois, Indiana, Kentucky, and western Ohio; the upper region, of the ORBES portions of eastern Ohio, Pennsylvania, and West Virginia.) Similar results are found when the annual sulfur dioxide and sulfate concentrations are examined.

Thus, both data and modeling confirm that long-range transport from the lower region contributes significantly to the concentration averages in the upper region and to violations of NAAQS in that region.

Finally, when the relationship between ORBES-region sulfur dioxide emissions and Canadian concentrations is examined, utility sulfur dioxide emissions from the ORBES region are shown to contribute about 50 percent of the sulfur dioxide and sulfate concentrations estimated to occur in southeastern Canada.

WATER. An analysis of the regional water quality in 1976 indicates the presence of high pollutant concentrations. These pollutants can be further concentrated by the diminished flow that occurs under 7-day-10-year low flow. In general, the minimum of the water quality standards in the ORBES states was used as a guide (since these standards vary from state to state and even from river to river). Approximately 19 of the region's 24 largest streams would have violated at least 3 of the 20 pollutant standards at some time in 1976 under 7-day-10-year low flow conditions. Moreover, if such conditions had occurred, aquatic habitat impacts could have been heavy on 14 of these 24 streams. (Heavy impacts are defined as entailing eutrophication, a concentration of heavy metals, possible stream dessication, local fish kills, and a recovery period of possibly five to seven years.)

LAND. If all energy-related land uses are considered, such land use through 1976 had affected 1.86 million acres in the ORBES region, or 1.5 percent of the regional land area. Land use for past and present surface mining of coal represents 86.9 percent of this figure (1.6 million acres); electrical generating facilities, 7.6 percent (140,700 acres); and transmission line rights-of-way, 5.5 percent (103,000 acres). In general, the reclamation of surface-mined land for permanent land use tends to be a slow process. Data are available only for a quarter of the region's 1.6 million affected acres.

These data show that this portion has been affected for 10 years and has not yet been fully reclaimed.

4. THE ISSUE AREAS OF CONCERN IN THE ORBES PROJECT

The ORBES study investigated possible impacts of an expanded generating capacity in the context of a number of issues. In the area of air quality, the study focused on the regional effects of changes in pollutant concentrations as a result of different levels of electrical generation, different control technologies, emission limitations, generating unit retirement schedules, and other factors. Examined in the context of the air quality analysis were the cost of electricity to the consumer, capital costs for pollution control devices, losses in agricultural output as the result of air pollution, and health impacts related to sulfates. In terms of land impacts, the study focused on land displacement for energy-related uses and the amount of land affected by surface mining. Another area investigated was water quality and quantity, including water consumption by electrical generating units, the effects of this consumption on pollutant concentrations (which increase as the water quantity decreases), and the effects of pollutant concentrations on aquatic habitats. The social areas chosen for analysis included labor demand for coal mining, labor demand for power plant construction and operation, and occupational death, disease, and disability from coal mining, processing, and transportation.

These topics were examined through a technology assessment approach. A variety of scenarios, all regionally based, were decided on and examined. Each scenario is thus an "as if" statement that does not predict what might happen. Rather, a scenario represents what one future might be like if assumed conditions are present in the ORBES region. Nine scenarios are compared in this report. First, those scenarios that assume an emphasis on coal as a fuel are compared. Next, those scenarios that assume a substitution of other fuels for coal or that emphasize conservation are compared with each other and with the coal-dominated scenario designated as the base case. The assumed economic and energy growth rates, as well as the assumed regional electrical generating capacity under each scenario in the year 2000, appear in table ES-1.

5. COAL-DOMINATED SCENARIOS

The five scenarios chosen for the most detailed analysis assume that coal will continue to be the dominant fuel used for regional electrical generation through the year 2000. The primary scenario of these five is the base case, the scenario to which all others are compared. Variations in base case environmental controls characterize two of the remaining four scenarios--the strict environmental control case and the noncompliance case. Variations in base case electricity demand growth account for the remaining two scenarios, the high electrical energy growth case and the electricity exports case. The latter case is so named because it also assumes that additional installed capacity in the ORBES region will transmit electricity to the northeastern United States to replace oil-fired capacity in that part of the country.

For the three scenarios that assume the same environmental standards—the base case, the high electrical energy growth case, and the electricity exports case--air and land standards are defined in terms of what currently exists as applied to present and future sources of pollution; in other words, these three scenarios reflect the full implementation of current air and land environmental policies. For water, the standards consist of current practices for the design and construction of industrial and municipal facilities. Power plant effluents, however, were assumed to be uncontrolled. The strict environmental control case, on the other hand, calls for more stringent environmental regulations. In the case of air, strict controls mean that the generally stringent pollutant emission standards for urban areas--which are set by current (as of September 1978) state implementation plans (SIPs)--would be applied throughout a state. For water, power plant effluent levels were assumed to be about 5 percent of base case levels. Strict environmental controls on land reclamation call for interim and permanent performance standards under the Surface Mining Control and Reclamation Act of 1977, but with strengthening of site-specific applications. Special interim and permanent standards are applied to steep-slope mining, mountaintop removal, the mining of prime farmland, and the surface effects of underground mining. Under the noncompliance case, it is assumed that emission limits in state implementation plans will not be met, but that the water and land environmental policies will be the same as under the base case.

Three of the five coal-dominated scenarios assume the same electricity demand growth rate: the base case, the strict environmental control case, and the noncompliance case assume an average annual rate of 3.13 percent through the year 2000. The electricity exports case, however, assumes an electricity demand growth rate of 3.2 percent, and the high electrical energy growth case assumes a rate of 3.9 percent. The high rate of electricity demand growth under the latter scenario is that suggested in recent estimates made by the National Electric Reliability Council (NERC).

The coal-dominated scenarios are further defined by a variety of energy and fuel use characteristics; growth rates for various sectors under each scenario appear in table ES-1. Also given in table ES-1 is the regional installed capacity that is projected to occur by 2000 under each scenario because of the electricity demand growth rates.

The same population, fertility, and economic growth rates were assumed for all five coal-dominated scenarios. Similarly, all scenarios assume that the coal to supply regional generating units will come from Bureau of Mines

Table ES-1
Growth Rates and Installed Capacity, ORBES Region, Annual Averages (1974–2000), by Scenario

Scenario	Economic Growth	Electricity Growth	Coal Growth	Natural Gas Growth	Refined Petroleum Growth	Energy Growth	Installed Capacity Year 2000 (MWe)
Base Case	2.47%	3.13%	2.40%	–0.40%	0.37%	1.49%	153,245
Strict Environmental Controls	2.47%	3.13%	2.47%	–0.40%	0.37%	1.53%	153,245
Noncompliance with State Implementation Plans	2.47%	3.13%	2.40%	–0.40%	0.37%	1.53%	153,245
High Electrical Energy Growth	2.47%	3.90%	N/A	–0.40%	0.37%	N/A	178,372
Exports of Electricity	2.47%	3.20%	2.77%	–0.39%	0.43%	1.73%	173,395
Natural Gas Substitution	2.47%	2.00%	0.74%	3.55%	0.51%	1.61%	113,595
Nuclear Fuel Substitution	2.47%	3.11%	1.52%	–0.40%	0.37%	1.50%	145,295
Alternative Fuel Substitution	2.47%	2.69%	1.73%	–1.20%	0.15%	0.95%	134,395
Conservation Emphasis	2.47%	0.90%	0.20%	–0.31%	–0.54%	0.10%	104,495

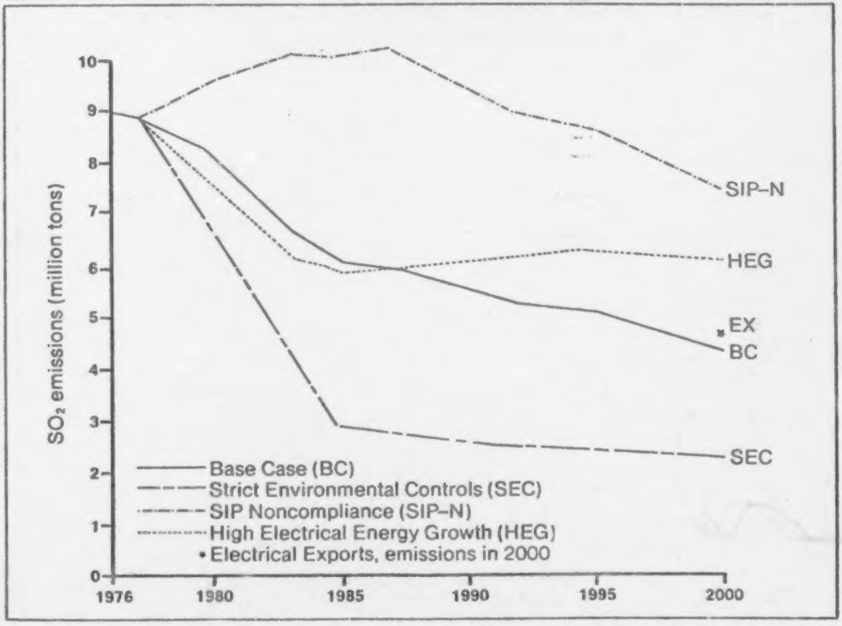
(BOM) districts in the six ORBES states (districts 1 through 4 and 6 through 11). All scenarios also assume that the regional generating units announced by the utility companies as of December 31, 1976, including both coal-fired and nuclear facilities, will be built as planned and that these facilities will come on-line on the dates announced by the utilities. Finally, all scenarios assume that sulfur dioxide emissions will be controlled through the use of flue gas desulfurization systems ("scrubbers") or the use of of local, blended low- and high-sulfur coals.

6. COMPARISON OF COAL-DOMINATED SCENARIOS

6.1 Emissions, Concentrations, and Air-Quality-Related Impacts

For all of the coal-dominated scenarios, utility emissions are the most important regional factor since their magnitude and their distribution consistently correlate with ambient air concentrations and, thus, with crop losses and mortality related to air quality. Under all coal-dominated scenarios, utility sulfur dioxide emissions would decrease by the year 2000 from their 1975 levels. However, the rate of decrease and the actual totals in 2000 would vary among the scenarios (see figure ES-4). Because of the scenario assumptions that produced the differences charted in figure ES-4, several observations can be made about possible strategies to reduce sulfur

Figure ES-4
Electric Utility Sulfur Dioxide Emissions in the ORBES Region, Coal-Dominated Scenarios

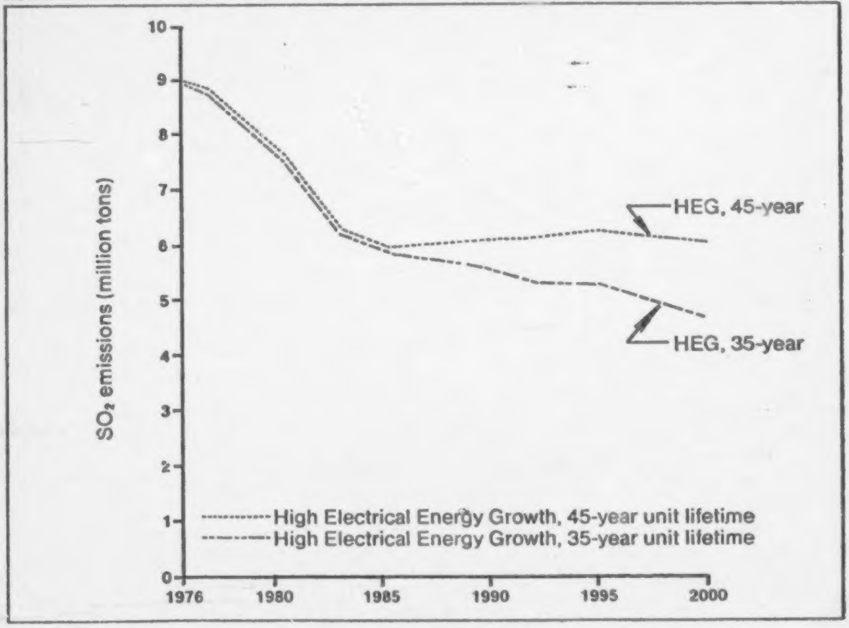


dioxide emissions at the individual plant level from their high 1976 levels. A discussion of mitigation strategies in an organizational context appears later in this summary.

SULFUR DIOXIDE

SIP Compliance. First, the base (compliance) case, the high electrical energy growth case, and the noncompliance case demonstrate how sensitive regional sulfur dioxide emissions are to compliance with and enforcement of SIP standards. Both the base case and the high growth case assume that complete SIP compliance will occur by 1985. As a result, under both scenarios, sulfur dioxide emissions are reduced continuously and dramatically between 1976 and 1985, and at about the same rate (see figure ES-5). The noncompliance scenario, however, assumes that there would be no utility compliance schedule; the SIP units would continue burning historical coals and using emission controls as in 1976. Thus, under this latter case, sulfur dioxide emissions

Figure ES-5
Electric Utility Sulfur Dioxide Emissions in the ORBES Region, High Electrical Energy Growth Case



actually would increase between 1976 and 1985, ensuring that the base period air quality problems would continue and perhaps get worse (see figure ES-6). Since nearly the same electrical generation is assumed in all three of these scenarios in 1985, the immediate benefits of SIP compliance are clear: total utility sulfur dioxide emissions could be reduced by one-third by 1985.

Plant Retirements. Utility sulfur dioxide emission patterns between 1985 and 2000 demonstrate yet another way to control emissions of this pollutant. After 1985, the level of utility sulfur dioxide emissions under the same three scenarios depends on the retirement of SIP units and the replacement and addition of present generating capacity by units governed by revised new source performance standards (RNSPS). Both the base case and the noncompliance case assume that SIP units will be retired after 35 years; the high growth case, on the other hand, assumes 45-year generating unit lifetimes. As figure ES-4 indicates, sulfur dioxide emissions thus decrease under the first two scenarios and increase slightly under the last scenario.

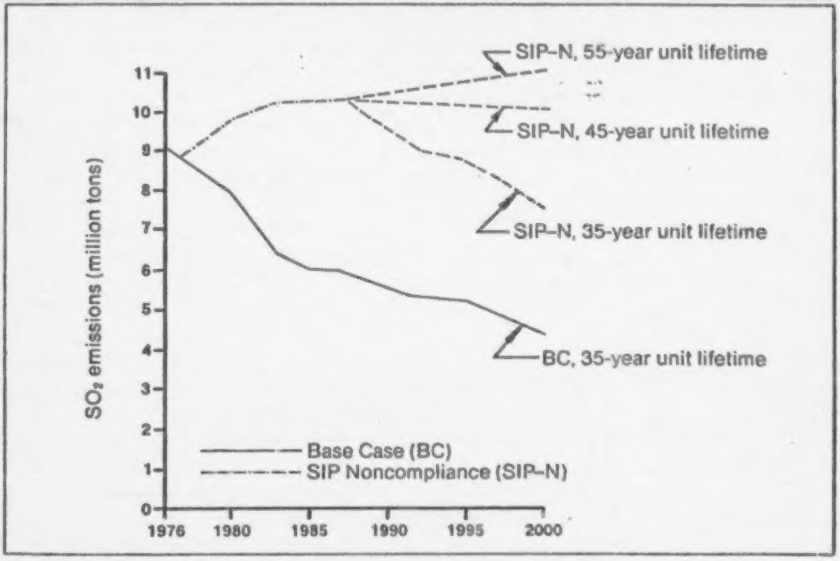


Figure ES-6
Electric Utility Sulfur Dioxide Emissions in the ORBES Region, Base Case and SIP Noncompliance Case

However, given the costs of installing new generating capacity and the costs of complying with the stricter NSPS and RNSPS controls, it is quite possible that utilities may postpone the retirement of SIP units. Under two scenarios--noncompliance and high growth--this possibility was examined briefly. Figure ES-5 indicates the sulfur dioxide emission levels that would occur under noncompliance if 35-, 45-, or 55-year generating unit lifetimes are assumed. Figure ES-6 compares the high growth case that assumes 45-year lifetimes with a variation that is identical except for a 35-year lifetime assumption. Both of these figures demonstrate the difference that early retirement of SIP units could have on regional sulfur dioxide emission levels.

The periodic maintenance of an existing plant can result in a substantial renovation of that plant. The effect of such an alteration is that the plant may not be retired as early as it would have been otherwise. If, however, certain modifications were considered major enough to warrant the reclassification of SIP units from an existing to a new source category, such a revised definition might result in a utility's evaluation of the relative merits of (1) continuing to use an existing unit or (2) building a new unit. If existing SIP units were retired through such an evaluation, substantial emission reductions could result.

The 35-year retirement of SIP units still would not wholly alleviate the air quality problems stemming from regional sulfur dioxide emissions. Even in 2000, SIP-regulated units would account for the bulk (at least 67 percent) of utility sulfur dioxide emissions, regardless of whether a 35- or 45-year life is assumed. However, SIP units would account for no more than 28 percent of the electrical generation in the year 2000 under any of the coal-dominated scenarios. Thus, the emissions contributed by SIP units would be disproportionate to the benefits of SIP generation in the year 2000. SIP units comprise such a major portion of the total utility emissions in 2000 and such a low percentage of the generation because they emit about five to six times more sulfur dioxide than a new plant supplying the equivalent amount of electricity.

Stricter Controls. One way to achieve a more balanced emission-generation ratio would be to make stricter the SIP compliance strategies currently in existence. The strict environmental control case offers an example of what might be expected if such stricter controls were enacted and enforced. This latter case assumes that in each ORBES state the urban SIPs--which are stricter than rural SIPs--would be applied throughout the ORBES portion of that state. As a result of such strict controls, by the year 2000, sulfur dioxide emissions would decrease more under this scenario than under any other coal-dominated scenario. Moreover, the rate of decrease would be more rapid (see figure ES-4).

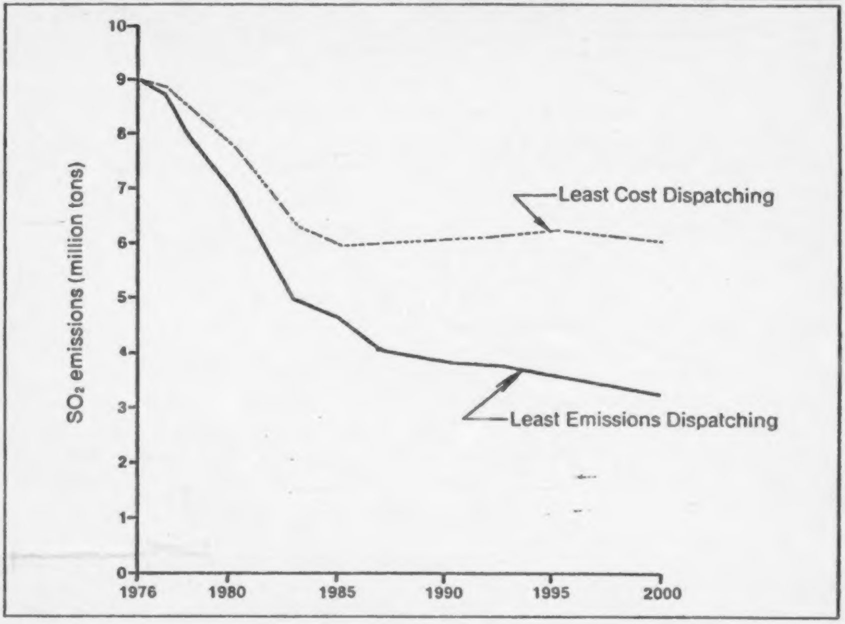
Least Emissions Dispatch. Another way to achieve a more balanced emission-generation ratio would be to use least emissions dispatching. At present, and under all of the coal-dominated scenarios, generating units are loaded (brought on-line) in order of operating costs. As a result, SIP units generally are the first units dispatched, since, as discussed previously, newer units are more expensive to operate. Under the high growth case, a variation was examined that assumed coal-fired units would be dispatched according to least emissions of sulfur dioxide. Under the least emissions criterion, the units emitting the most sulfur dioxide (on a per Btu basis) would be loaded last. Under one such dispatching order, for example, RNSPS units might be dispatched first, then NSPS units, then urban SIP units, and finally rural SIP units. However, such a dispatching order may not always be feasible.

Under this least emissions policy, total regional utility sulfur dioxide emissions would be 55 percent lower than they would be under the least cost policy in the year 2000 (see figure ES-7). SIP emissions alone would be 35 percent lower under the former case than under the latter case. Moreover, in the year 2000 under the least emissions dispatching variation, a more balanced emission-generation ratio would be achieved. Under least emissions dispatching, SIP units would emit 1.5 million tons of sulfur dioxide--or 45 percent of all utility sulfur dioxide emissions--and generate about 171 million megawatt hours. Under the least cost policy, on the other hand, SIP units would emit 4.32 million tons of sulfur dioxide--or 71 percent of the total emissions--and generate only about 162 million megawatt hours.

As this discussion of sulfur dioxide emissions under the different coal-dominated scenarios thus has revealed, the current emission standards, if complied with, would reduce total sulfur dioxide emissions between 1976 and 1985 from the 1976 levels. Any further reductions would be determined by the lifetime of SIP plants. As will be discussed shortly, such further reductions would be important since episodic concentrations still would result from the 1985 emission levels of most of the scenarios. Before such concentrations are discussed, however, particulate and nitrogen oxide emission trends under these coal-dominated scenarios are examined.

PARTICULATE EMISSIONS. Utility particulate emissions would be reduced significantly by the year 2000 from the 1976 levels under all of the coal-dominated scenarios except the noncompliance case. Moreover, except under the latter scenario, particulate emissions would be reduced at about the same rate and would be about the same in 2000--nearly five times lower than the 1976 emissions (see figure ES-8). In addition, such variations as least emissions dispatching would result in emissions about the same as those charted in figure ES-8. Noncompliance, however, would result in increased particulate emissions through 1985. In 2000 under noncompliance, particulate emission levels would be only slightly lower than the 1976 levels. These scenarios

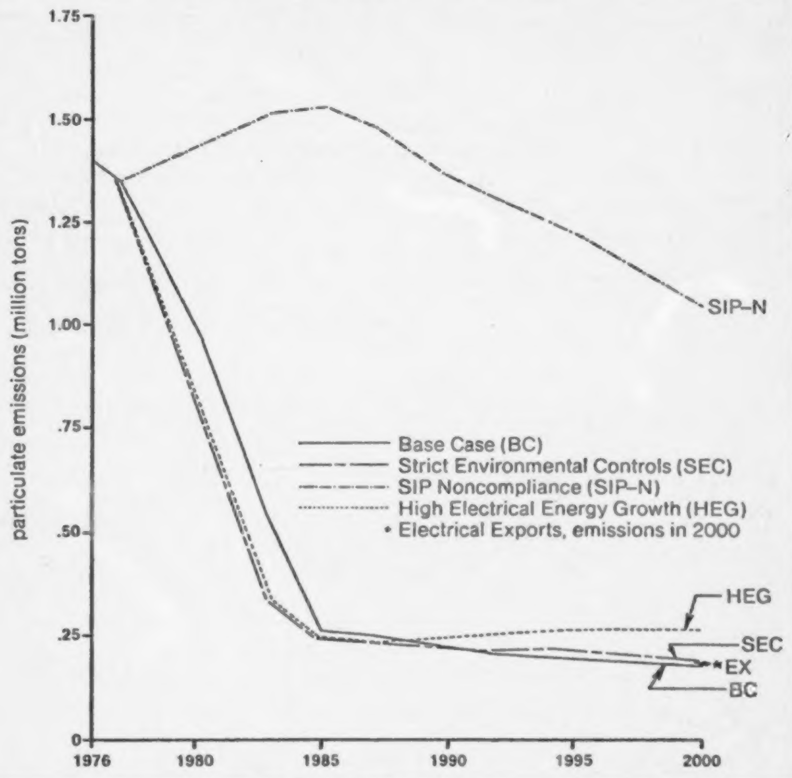
Figure ES-7
Electric Utility Sulfur Dioxide Emissions in the ORBES Region, Dispatching Variations under High Electrical Energy Growth



thus suggest that current particulate standards--which are the same in urban and rural settings--will be effective. One major reason for this effectiveness, however, is that particulate removal technology is assumed to be between 85 and 94 percent efficient depending on when the unit was built.

NITROGEN OXIDE EMISSIONS. All scenarios would result in increased utility nitrogen oxide emissions. Similarly, except under the high electrical energy growth scenario, utility nitrogen oxide emissions would increase at about the same rate through 1985 and would be nearly the same in 2000—approximately 35 percent higher than 1976 emissions (see figure ES-9). There are two reasons for the similarity among scenarios. First, nitrogen oxide emission limits do not exist for SIP plants in the ORBES region, except in the urban areas of Illinois. Second, the same emission limits were assumed for new units under all scenarios. Thus, nitrogen oxide emissions would increase from the 1976 levels primarily in proportion to electricity demand growth and to the lifetime of SIP units. This fact also explains why, after 1985, nitrogen

Figure ES-8
Electric Utility Particulate Emissions in the ORBES Region, Coal-Dominated Scenarios

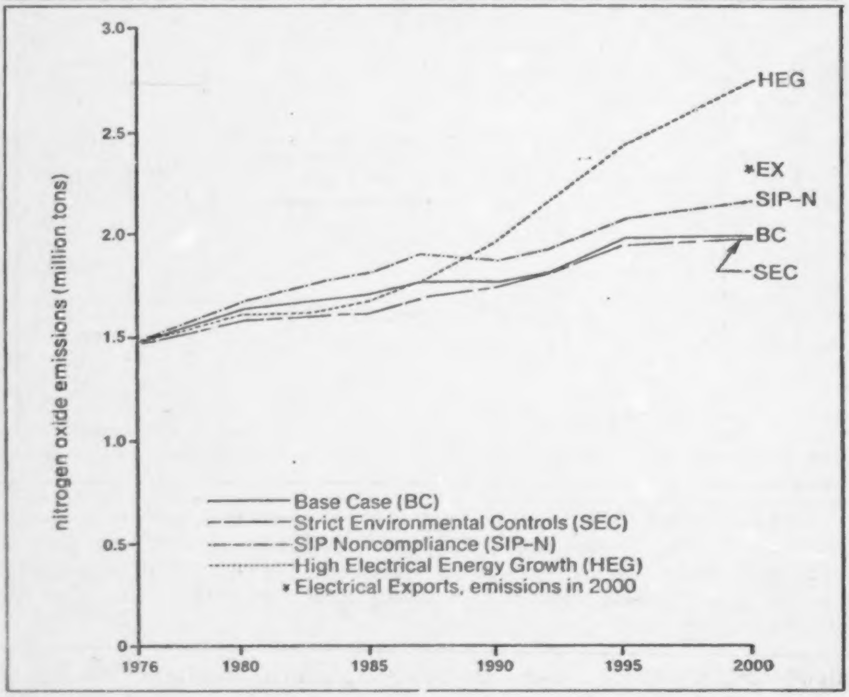


oxide emissions would increase under the high electrical growth case at a faster rate than under the other scenarios: the high growth case has the highest electricity demand growth and assumes 45-year SIP unit lifetimes instead of the 35-year lifetimes assumed under the other coal-dominated scenarios.

POLLUTANT CONCENTRATIONS. The magnitude of changes in utility sulfur dioxide emission levels under each scenario corresponds to changes in annual average (or long-term) and episodic (short-term) regional sulfur dioxide and sulfate concentrations. Moreover, since, as discussed earlier, the transformation of sulfur dioxide into sulfates contributes to concentrations of total suspended particulates, reductions in both utility particulate emissions and utility sulfur dioxide emissions could reduce measured TSP concentrations. However, the ratio of the lower ORBES region's contribution to concentrations in the upper region is not likely to change from the ratio during the base period under any of the scenarios.

Many of the same statements made about emissions under the various scenarios also apply to comparisons of the scenarios and their annual concentrations. For example, regardless of scenario, the regional sulfur dioxide and sulfate concentrations in 2000 attributable to utility emissions

Figure ES-9
Electric Utility Nitrogen Oxide Emissions in the ORBES Region, Coal-Dominated Scenarios



would be lower than the present concentrations. Again, it is the strict environmental control case that would reduce the annual average concentrations the most and that would reduce them more rapidly than any of the other scenarios (see table ES-2). Similarly, the high electrical energy growth case and the noncompliance case would result in the least reduction by the year 2000. In fact, the 1976 concentrations would even increase through 1985 under the noncompliance case. In general, most concentration reductions would occur by 1985--regardless of scenario--if SIP plants have complied by that date. Figures ES-10 and ES-11 illustrate the reductions in annual average sulfur dioxide and sulfate concentrations under the base case in 2000 as compared with the 1976 concentrations.

Another benefit of lower utility sulfur dioxide emissions is the probable reduction of the concentrations that would occur under episodic conditions. If the characteristics of the August 27, 1974, sulfate episode were to be repeated in 2000 under any of the scenarios, the predicted utility-related, short-term sulfur dioxide and sulfate concentrations would be reduced from the utility-related, short-term concentrations that were registered during that episode (see table ES-3). However, since these short-term concentrations were quite high during the August 27 episode (the most frequently occurring type of episode in the ORBES region) even the 49 and 51 percent reductions that would occur in 2000 under the base case would result in short-term sulfur dioxide levels on the order of 30 micrograms per cubic meter and in short-term sulfate levels that would be considered marginally episodic--that is, on the order of 15 micrograms per cubic meter over a large area. On the other hand, the strict environmental control case would lead to reductions of such magnitude that the short-term levels of sulfur dioxide and sulfates no longer would be

Table ES-2
Sulfur Dioxide and Sulfate Annual Average Concentrations, ORBES Region, Percent Change from 1976, Highest Concentration Region

Pollutant	Concentration, 1976 ($\mu g/m^3$)	Year	Base Case	Strict Environmental Controls	SIP Noncompliance	High Electrical Energy Growth
				(%)		
Sulfur dioxide	25.88	1985	-28	-62	+16	-30
Sulfur dioxide	25.88	2000	-50	-71	-18	-29
Sulfates	9.2	1985	-27	-56	+13	-25
Sulfates	9.2	2000	-49	-66	-20	-25

Figure ES-10
Annual Average Sulfur Dioxide Concentrations, Electric Utility Contribution

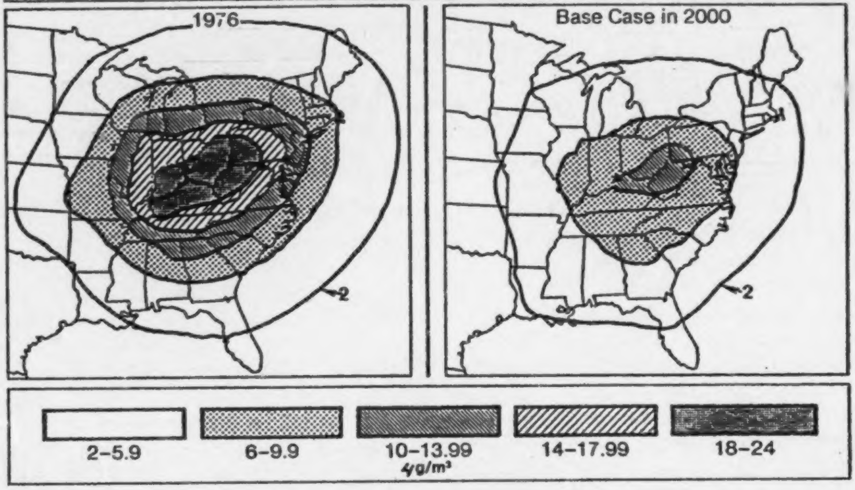
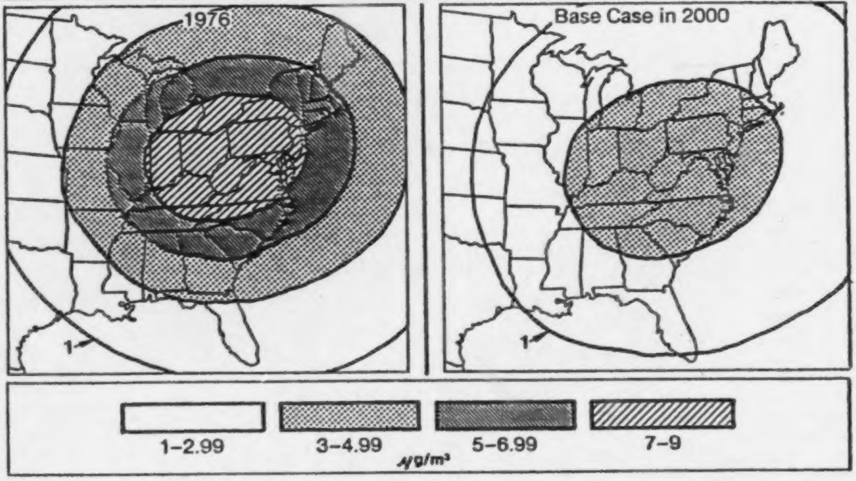

1976
Base Case in 2000
2
2
2-5.9
6-9.9
10-13.99
14-17.99
18-24
µg/m³

Figure ES-11
Annual Average Sulfate Concentrations, Electric Utility Contribution


1976
Base Case in 2000
1
1
1-2.99
3-4.99
5-6.99
7-9
µg/m³

considered episodic. As can be deduced, therefore, the noncompliance and the high growth cases, which reduce emissions the least by 2000, would result in relatively high episodic concentrations.

Annual average and episodic concentrations are important in terms of both regional crop loss impacts and regional health impacts (among other things) since the reductions in concentrations consistently correlate with less crop loss and fewer health impacts.

PHYSICAL CROP LOSSES. In terms of agricultural impacts, studies have indicated that sulfur dioxide concentrations as low as 130 micrograms per cubic meter (one-tenth of the secondary three-hour standard) in the presence of moderate ozone levels (0.06 to 0.1 parts per million) can affect vegetation. Thus, three coal-dominated scenarios--the base case, the noncompliance case, and the high growth case--were examined to determine the regional acreage that could be affected by the sulfur dioxide concentrations attributable to ORBES-region utility emissions. Each of these three scenarios also was examined to determine the impact of such affected acreage on crop yields, and it was found that crop yield losses would not be as high in both 1985 and 2000 as they were in 1976. However, because utility sulfur dioxide emissions would be higher under the noncompliance case and because more acreage would be affected by the resulting sulfur dioxide concentrations of 130 micrograms per cubic meter, noncompliance would result in the highest losses. Nevertheless, regardless of the scenario, physical crop losses related to utility sulfur dioxide emissions would represent less than 1 percent of the expected regional yield in any given year. Thus, from this regional perspective, the direct effects of sulfur dioxide emissions in the ORBES region on agricultural losses can be thought of as negligible under all three of these scenarios.

Table ES-3
Sulfur Dioxide and Sulfate Episodic Concentrations, ORBES Region, Percent Change from August 27, 1974, Episode, Highest Concentration Region

Pollutant	Concentration, 1976 (μg/m)	Year	Base Case	Strict Environmental Controls	SIP Noncompliance	High Electrical Energy Growth
				(%)		
Sulfur dioxide	94.04	1985	–31	–68	+18	–34
Sulfur dioxide	94.40	2000	–49	–75	–13	–30
Sulfates	40.10	1985	–25	–76	+16	–23
Sulfates	40.10	2000	–51	–78	–30	–18

The majority of regional crop losses are the result of oxidants formed from hydrocarbons and from nitrogen oxide emissions. Nitrogen oxide emissions in the ORBES region originate primarily from transportation and from electrical generation. However, it is projected that nitrogen oxides from transportation will decrease significantly by the year 2000. Thus, utility nitrogen oxide emissions will begin to constitute a larger proportion of the regional nitrogen oxide emissions, especially since nitrogen oxide standards do not yet exist for SIP units in the ORBES region and since SIP-unit emissions are projected to account for the majority of all utility emissions. As a result, the rate of decrease in ozone production as well as the rate of decrease in ozone-related crop losses may be dictated by utility nitrogen oxide emissions.

In general, regardless of the scenario, losses due to oxidants would constitute about 99 percent of all the losses expected because of sulfur dioxide and ozone. Moreover, the distribution of the losses due to oxidants would vary among state portions. However, the ORBES state portions of Illinois, Indiana, and Ohio would account for about 95 percent of both sulfur dioxide and ozone losses. Finally, the distribution of all crop losses due to air pollution is not merely a local problem--that is, merely in the vicinity of a power plant--but, because of pollutant transport, these losses may occur in areas removed from major point sources. The dollar losses related to crop losses due to sulfur dioxide and all oxidants are given in section 6.2.

MORTALITY. Substantial controversy exists about the quantification of deaths related to air quality. Yet increasing evidence exists to support the hypothesis that the annual average exposure to sulfates--or something closely related to them--results in an increased mortality rate. Therefore, cumulative sulfate-related deaths between 1975 and 2000 were projected for the coal-dominated scenarios. Such projections depend on the damage function employed since rates between 0 and 9 per 100,000 persons exposed per microgram of sulfates per cubic meter are found in the literature. If a rate of 3 is used, it becomes clear that the magnitude of utility emissions is a dominant factor: the strict control case would result in the lowest number of cumulative deaths, while the noncompliance case and the high growth case would result in the most such deaths. Cumulative sulfate-related deaths under the latter two scenarios also would be nearly 34 and 13 percent higher, respectively, than would the deaths under the base case.

6.2 Economic Impacts Related to Air Quality Impacts

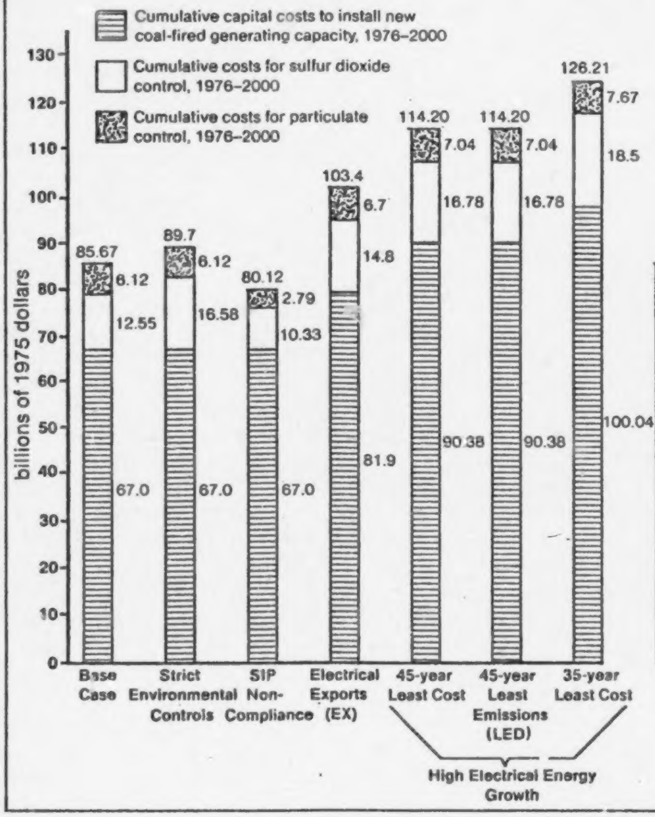
The costs to the utilities and to the consumer of the possible reductions in emissions and other air-related impacts also were projected for the five coal-dominated scenarios as well as for the least emissions variation and the high electrical energy growth case with a 35-year lifetime variation. Agricultural monetary losses also were estimated for three scenarios--the base case, the noncompliance case, and the high growth case. Knowing these costs permits comparisons to be made among the scenarios in terms of the social benefits derived from reduced emissions versus the economic impacts of such reductions.

UTILITY COSTS. Figure ES-12 charts the costs to the utilities of installing new coal-fired generating capacity, of installing pollution control devices on these new units, and of retrofitting existing units. As shown in this figure, the base case, the strict control case, and the noncompliance case would result in the same capital costs but in different pollution control costs. The differences in pollution control costs among these three scenarios would result entirely from the retrofitting of existing SIP plants with pollution control devices. Thus, the total cumulative pollution control costs for the base case would be higher than those under the noncompliance case because under the base case about one-third of existing capacity would be retrofitted. Under the strict control case, on the other hand, almost all of the existing capacity would be retrofitted, resulting in the highest cumulative pollution control costs of the three scenarios.

The high growth case and its variations and the export case would result in higher costs to the utilities than would the first three scenarios. These higher costs, however, would be due to the costs of installing the expanded generating capacity and the pollution control devices on this new capacity. Thus, if the proportion of pollution control costs to total capital costs is examined, the base case and the high growth case are similar: under both scenarios, pollution control costs would total about 21 to 22 percent of the total costs. It should be noted, however, that these total capital costs do not reflect the operating costs. The operating costs are included in the calculation of the price of electricity, which reflects all the costs borne by the utilities each year. Thus, for example, while the high growth scenario and the high growth least emissions variation are projected to have the same capital costs, there would be differences in their operating costs since the least emissions dispatching variation would require increased operation of pollution control devices and the burning of greater quantities of cleaned or low-sulfur coals.

CONSUMER COSTS. The direct costs to the consumer would increase regardless of scenario. In the short run, however, some scenarios may result in a faster rate of increase in the price of electricity (see figure ES-13). Several observations can be made about the electricity prices and their rate of increase. For one, between 1976 and 1985, the price of electricity rises according to the added costs of complying with SIP emission limits, paying for rising fuel and capital costs, and meeting electricity demand. Thus, as figure ES-13 indicates, the price of electricity between 1976 and 1985 would

Figure ES-12
Cumulative Capital Costs, Coal-Dominated Scenarios, 1976–2000

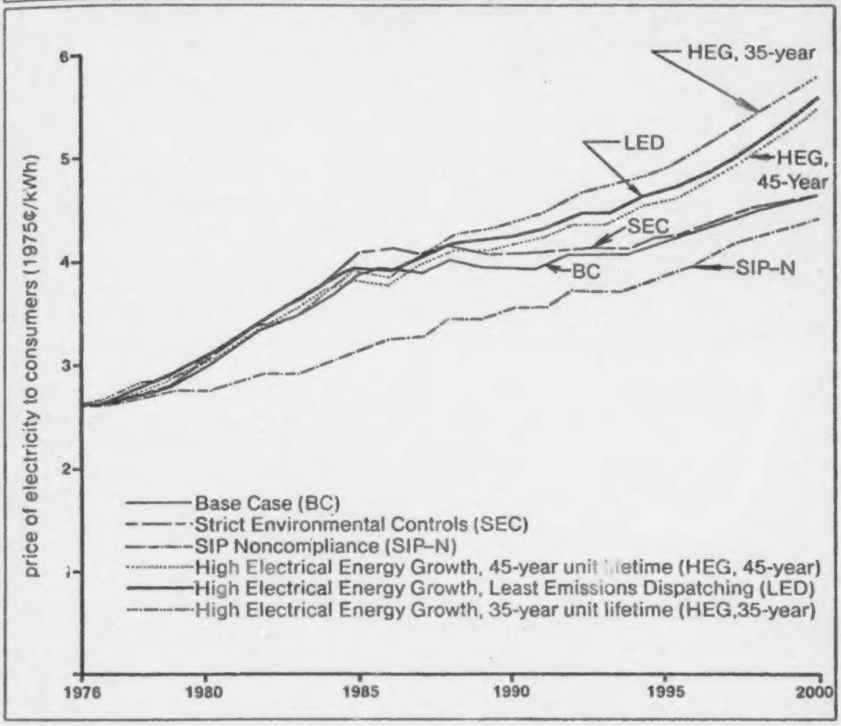


Cumulative sulfur dioxide and particulate control costs

Scenario	costs billion $	% total costs
BC	18.67	21.8
SEC	22.7	25.3
SIP-N	13.12	16.4
EX	21.5	20.8
HEG	23.82	20.9
LED	23.82	20.9
35-Year	26.17	20.7

rise similarly when nearly the same degree of compliance is assumed--that is, under all the scenarios but the noncompliance case. The strict environmental control case, however, would result in the greatest increase in electricity prices since complying with stricter SIP standards would cost the utilities more. The price of electricity under the noncompliance case, of course, reflects the absence of such control costs.

Figure ES-13
Electricity Prices in the ORBES Region, Coal-Dominated Scenarios



Between 1985 and 1995, the rise in electricity prices depends on the annual electricity demand growth rate, capacity replacement, and capacity expansion. Since the base case, the strict control case, and the noncompliance case assume nearly the same replacement, expansion, and growth rates, the price of electricity would rise little between these years. Under the high growth scenario and its variations, however, the price of electricity rises between 1985 and 1995 since more capacity expansion is projected under these scenarios. The greater operating costs of least emissions dispatching also are reflected in the higher price of electricity under this variation.

Between 1995 and 2000, all scenarios show a rise in the price of electricity. This increase would result because additional generating units must be constructed to satisfy electricity demand after the year 2000 and because a significant number of SIP units will retire during these years and must be replaced.

Because some scenarios would cause electricity prices to be higher in the short run, the cumulative costs to consumers between 1976 and 2000 give a better idea of the total consumer costs than the price of electricity in a given year. Under the compliance or base case, such cumulative revenues required from consumers would total $525 billion (1975 dollars, or approximately $709 billion in 1979 dollars). Compared to the base case revenues, the cumulative revenues required under the strict environmental control case would be about 4 percent higher, while the revenues required under the noncompliance case would be about 10 percent lower. A high electrical energy growth rate would require about 18 percent more revenues than would the base case. Of the two high growth variations, the 35-year variation would require the most revenues (about 21 percent higher than the base case), while the revenues required by the least emissions dispatch variation would be about 19 percent higher than under the base case.

MONETARY CROP LOSSES. When comparing the agricultural monetary losses that would occur because of physical crop losses due to sulfur dioxide and oxidants, some of the same statements made under the physical crop loss discussion can be repeated. First, monetary losses of oxidant-related crop losses would constitute virtually all (about 99 percent) of the economic losses under all of these scenarios. In addition, monetary losses related to the crop losses due to sulfur dioxide emissions would be similar under the three scenarios examined (less than 1 percent of the total monetary losses). Also, the total agricultural monetary losses would be concentrated in certain ORBES state portions (Illinois, Indiana, and Ohio) regardless of scenario. Finally, the high growth case would result in the highest cumulative agricultural monetary losses ($8.4 billion in 1975 dollars, or approximately $11.3 billion in 1979 dollars). The base case and the noncompliance case would result in about the same cumulative agricultural monetary losses ($7 billion in 1975 dollars, or approximately $9.5 billion in 1979 dollars).

6.3 Other Impacts Related to Expanded Capacity

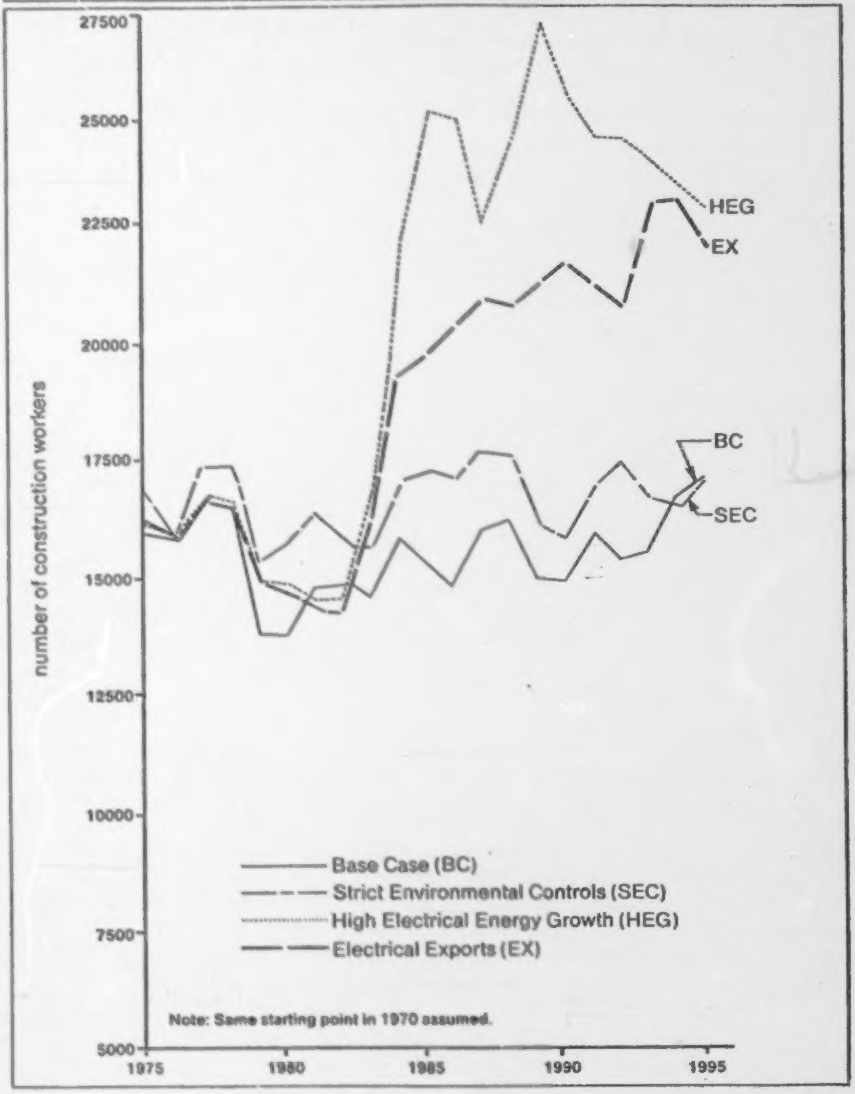
LAND. The regional impacts of an expanded utility industry on land use would be about the same for three of the coal-dominated scenarios--the base case, the strict environmental control case, and the noncompliance case--since their generating capacity is about the same and their siting patterns somewhat similar. The base case, for example, converts about 184,000 acres, or 0.15 percent of the ORBES region, for generating facility use through 2000. However, although the regional acreage affected would be about the same under all three cases, affected acreage at the state level would vary slightly. Policies that encourage high electrical energy growth or the export of electricity from the region would result in much larger generating capacities than the three other coal-dominated scenarios. Thus, the land converted would be about 30 percent higher under the high growth case than under the base case; under the export case, land conversion would be about 17 percent higher than it would be under the base case.

EMPLOYMENT. An increase in the employment of power plant construction and operation workers would be expected under both the high electrical energy growth case and the electrical exports case. In fact, such employment would rise dramatically under these two scenarios between 1983 and 1987, although the high growth scenario would require more workers than the export case (see figure ES-14). However, such rapid changes as occur under the high growth case could result in short-term labor shortages followed by a surplus of labor as experienced workers have a choice of jobs and then few choices. Moreover, shortages of the skilled labor necessary to power plant construction and operation--such as boilermakers, pipefitters, and electricians--might accompany the high growth case. In general, however, skilled labor shortages would not be a major problem for the region under any of the other coal-dominated cases, although local shortages could possibly occur.

Annual coal production in the region for all purposes and mining employment would increase under the base case, the strict environmental control case, and the electrical exports case. However, annual coal production would be much higher in 2000 under the electrical exports case than it would be under the other two scenarios. Thus, regional mining employment would rise similarly under the base case and the strict control case, from a minimum of 36 percent to a maximum of about 226 percent, depending on the county. Such employment would increase from a minimum of 42 percent to a maximum of 270 percent under the electrical exports case. It is also projected that at least 79 to 88 of the 152 ORBES counties with a concentration in coal mining would experience boom-town effects (growth over 200 percent) under all three of these scenarios.

HEALTH. Under all of the coal-dominated scenarios, the health impacts related to supplying coal to ORBES power plants would increase. This increase results because, under all scenarios, coal production as well as electric utility coal consumption would rise from current levels. In 1985, the increases in the health impacts in the coal-mining and coal-processing sectors would be the same under all coal-dominated scenarios. In 2000, three of the scenarios--the base case, the strict control case, and the noncompliance case--would result in similar health impacts in these sectors, while the high growth case and the exports case would result in impacts about 17 percent higher. The health impacts in the coal transportation sector were analyzed only for the base case and the strict control case and only for the year 2000. Both cases would result in an increase in the fatalities associated with transport to ORBES electrical generating facilities, but in the same number of injuries as currently since railroad injuries are projected to decline at a greater rate than fatalities.

Figure ES-14
Construction Workers, Coal-Dominated Scenarios, 1975–95



WATER QUALITY. A comparison of the water quality analyses conducted for the coal-dominated scenarios reveals that none of these scenarios would result in aquatic habitat impacts very different from each other or from those that could have occurred in 1976 under 7-day-10-year low flow conditions. Thus, whether historical municipal and industrial growth continues, or whether low, high, or base case electricity demand occurs, the region already appears to have the potential to experience its most serious aquatic habitat impacts under 7-day-10-year low flow conditions. However, although overall aquatic habitat impacts change little under most of these scenarios, under the strict control case and the high growth case, some rivers would register perhaps slightly less or more stress than they would under the base case.

Background Concentrations. The reason why the majority of the streams would experience the same impacts under the scenarios as they would under 1976 conditions concerns the high background concentration levels that exist in the region. As noted under the base period discussion (sec. 3), 19 of the 24 streams studied could have violated several of the study's reference concentrations under 7-day-10-year low flow at some time in 1976. Further, the overwhelming majority of these high background concentrations are estimated to be geochemical or to originate from nonpoint sources under conditions of higher flow. Since the likelihood of bringing nonpoint sources under control during the time frame of this study is considered almost impossible by most experts, background levels in the ORBES streams were projected to remain constant between 1975 and 2000 under all scenarios except the strict control case. Under the strict control case it was assumed that background levels would be reduced by half by the year 2000. (It also was assumed under this case that power plant effluent loadings would be reduced 95 percent from the base case loadings.) Such calculations reveal that if such a reduction were to occur, aquatic habitat impacts would remain about the same although slightly less stress would be experienced on all rivers. The results under the strict control case thus suggest that background levels are so high that they would have to be reduced by more than half to avoid serious aquatic habitat impacts under 7-day-10-year low flow conditions.

Loadings. The influence of these background concentrations is further indicated when the effluent loading assumptions of these scenarios are compared. Under all of the coal-dominated scenarios except the strict environmental control case, power plant effluents were not limited. The strict control case, however, along with its assumption of reduced concentrations, assumed that energy conversion facilities would operate at 5 percent of base case levels. However, a comparison of the strict control case with the other coal-dominated cases--the base case, for example--reveals little difference because of the loading assumptions. Although slightly less stress would occur on all rivers under strict controls, aquatic habitat impacts remain the same as under the base case on all but four rivers. If the impacts under the strict control case then are compared to those that could have occurred in 1976, only two rivers would register changes from the 1976 aquatic habitat impacts. Thus, since loading is not a significant factor, background concentrations appear mainly responsible for the substantial impacts that could occur under 7-day-10-year low flow conditions.

Consumption. Power plant consumption would be important on those of the region's smaller streams where little municipal and industrial consumption occurs and where flow under 7-day-10-year low flow conditions would be curtailed drastically. However, if background concentrations were not so high on these small streams, power plant consumption might have little impact. Thus, once again the high background levels are more important than the consumption source.

What the impacts on these small streams suggest is that alternative siting or technology could alleviate almost all power-plant-related impacts on water quality under all scenarios. There is, however, one, perhaps significant, problem with alternative siting of power plants. Although water quality would be protected, air quality would suffer since most of the suitable alternative sites in terms of water quality are located along the Ohio River main stem, where air quality problems exist. A further concentration of power plants in this area thus could exacerbate these air quality problems.

What can be done to avoid the combined effects of natural forces and high background concentrations thus is hard to pinpoint, especially if it is unlikely that nonpoint sources can be brought under control. Preventing the rather minor power-plant-related impacts would necessitate the tradeoff just discussed. Avoiding the potentially significant impacts of municipal and industrial consumption also would involve tradeoffs. If, for example, regulatory bodies were to implement siting restrictions that prohibit the siting of any entity that consumed water along streams having 7-day-10-year low flows less than 100 cubic feet per second, a number of rivers would not be available for growth of any kind. This condition would result in a very limited number of sites for industry, especially for power plants. Thus, as this brief outlining of some possible steps and their limitations suggests, improvements in water quality may require some environmental, social, and economic tradeoffs that would have their own repercussions.

7. MITIGATION STRATEGIES

On a regional scale, existing institutional mechanisms are inadequate to ameliorate air quality impacts, many of which transcend political boundaries both inside and outside the ORBES region, particularly to the northeast.

TECHNICAL STRATEGIES. A variety of technical strategies, usually applied on a plant-by-plant basis, could be more effective if implemented regionally.

Among the technical strategies discussed in the context of the ORBES scenarios (see sec. 6.1) are the use of flue gas desulfurization systems, or "scrubbers"; least emissions dispatching; modified plant retirement schedules; and stricter environmental standards.

TECHNO-ORGANIZATIONAL STRATEGIES. In contrast to technical strategies, which usually are applied at single generating units or within a single utility service area, techno-organizational strategies are broader and could be developed on an interstate, multistate, or regional scale. The need for such strategies arises from transboundary air pollution transport, which can be divided into two types: (1) local transboundary air pollution transport (the movement of air masses is over relatively short distances across state lines and the contributions from individual plant sources usually can be identified) and (2) long-range transboundary air pollution transport (the air masses travel longer distances, often across several state lines, and the contributions from individual sources are difficult to isolate).

Local Transboundary Transport. Local transboundary air pollution transport is treated in the Clean Air Act, in provisions that attempt to make a state responsible for pollution that originates within its borders but is transported short distances into other states. At present, action is pending on at least three petitions filed by several ORBES-region states in regard to air pollution generated by power plants in neighboring states. Protracted legal proceedings on related local transboundary pollution questions also have taken place in the region within the context of the Clean Air Act.

Long-Range Transboundary Transport. Long-range transboundary air pollution transport, on the other hand, is not covered specifically in the Clean Air Act. However, as discussed previously (sec. 6.1), long-range transport contributes to violations of NAAQS in the upper ORBES region. Thus, air quality in the ORBES region and beyond could be improved if there were a regionwide techno-organizational strategy for determining expected emissions from coal-burning plants, siting new plants, and operating both existing and new facilities. A coordinated strategy is necessary because of the interdependency of emission reductions, siting, and operations.

A coordinated siting mechanism could help to reduce pollutant concentrations at local "hot spots," where these concentrations are highest. However, total regional pollutant loadings would remain the same whether a regional siting mechanism is developed or not. Thus, regional coordination appears to be required to reduce pollutant loadings and/or to reduce concentrations from long-range transboundary pollution in the ORBES region and beyond.

Utilities and State Governments. If new organizational approaches are to be devised in a meaningful way, both the states and the electric utilities must participate. Voluntary cooperation among utility companies is one possibility, but it may not be realistic to expect utilities in different states to work together in activities aimed at the mitigation of negative transboundary air quality impacts. Moreover, cooperation would have to encompass operations as well as siting if extraregional impacts were to be mitigated.

If utilities were to agree upon the desirability of cooperation in either siting or operations across state lines, the most appropriate organizational arrangements are not clear. At present, utilities are regulated by individual states, and most utility service areas follow state lines. Thus, voluntary cooperation across state lines probably would be difficult. Yet the utilities do engage in interstate cooperation in several other areas, principally in the assurance of electric power reliability. It is conceivable that regional reliability councils now in operation could stimulate further cooperation. Indeed, the expansion of existing federal legislation might encourage cooperative siting, if not cooperative operations. Cooperation among the states in this regard also should be examined, but prospects do not appear promising. In only one ORBES state, Ohio, has the legislature mandated admininstrative leaders to seek cooperation with other states in developing mitigation strategies. Ohio is also the only ORBES state with a "one-stop" siting procedure; if similar arrangements existed in the other ORBES states, they might provide a vehicle for interstate discussions on siting problems.

Interstate Compacts. Another potential vehicle is the interstate compact. For example, an existing compact, the Ohio River Valley Water Sanitation Commission (ORSANCO), might be expanded in scope to permit supplementary agreements, between two or more member states, to resolve transboundary air pollution conflicts and other problems related to interstate facility siting and possibly operations.

No interstate compact to mitigate long-range transboundary air pollution is known to operate anywhere in the country at this time. However, the Delaware River Basin Compact has organizational elements that could be relevant in the consideration of such a mechanism for the ORBES region. For example, the Delaware compact has been instrumental in obtaining interstate approval of power plant sites.

Other Regional Bodies. The Tennessee Valley Authority (TVA) cannot be ignored in any consideration of mitigation strategies. A portion of Kentucky is included in the TVA area, and problems of long-range transboundary air pollution transport are shared by the TVA area and the ORBES region. In fact, the two areas are connected in so many ways as to make separate treatment impossible.

Other regional bodies that should be considered in this context are the Ohio River Basin Commission and the Appalachian Regional Commission (ARC). Some have suggested that the ARC's functions be expanded so that this organization could address air impacts in the Ohio River valley and perhaps participate in interstate siting. However, the proposal has found little support.

Federal Action. The most likely federal initiatives will center on the Clean Air Act; an upcoming debate in Congress will review the entire act, including the 1977 amendments. The most extreme possibility, federal preemption, is considered unlikely.

8. FUEL SUBSTITUTION AND CONSERVATION SCENARIOS

Four scenarios investigate energy and fuel use characteristics that differ from those of the coal-dominated scenarios (see table ES-1). Three of the cases assume relatively less emphasis on coal use for electrical generation because of partial substitution by other fuels. In the natural gas substitution case, natural gas is substituted for other fuels whenever practicable, but not to fire utility boilers. In the nuclear fuel substitution case, nuclear-fueled electrical generating capacity substitutes directly for coal-fired capacity. In the alternative fuel substitution case, a variety of alternative fuels, including biomass and solar energy, partially replace coal-fired capacity. The fourth case assumes that energy growth in the ORBES region is significantly less than under all other scenarios because of the implementation of conservation measures. All four cases are compared with the coal-dominated base case.

The same regional population, fertility, and economic growth rates are assumed in the four scenarios discussed here as are assumed in the coal-dominated case. Moreover, base case environmental controls are assumed under all four scenarios. Finally, the same assumptions as under the coal-dominated scenarios are made concerning the mining for utility coal and the utility-announced capacity.

9. COMPARISON OF FUEL SUBSTITUTION AND CONSERVATION SCENARIOS

An analysis of these fuel substitution and conservation scenarios suggests that all of these scenarios would reduce the emission-related impacts that are projected to occur under the coal-dominated base case. Other across-the-board comparisons, however, are more difficult to make.

9.1 Emissions, Concentrations, and Air-Quality-Related Impacts

EMISSIONS. Utility sulfur dioxide emissions would be only slightly lower in 2000 under the fuel substitution and conservation scenarios than under the base case (see table ES-4) even though substantially fewer coal-fired units would be added under the substitution and conservation scenarios. The conservation case would reduce sulfur dioxide emissions the most (resulting in emissions 11 percent lower than under the base case), and the nuclear substitution case would reduce them the least (resulting in emissions only 3 percent lower).

The expanded use of SIP generating units under each of the fuel substitution and conservation scenarios explains why these scenarios would result in sulfur dioxide emissions quite similar to those of the base case. Under both the conservation emphasis case and the natural gas substitution case, fewer new generating units would be built than under the base case; under the nuclear fuel substitution case, new units added after 1985 would be nuclear fueled rather than coal fired. As a result, SIP-regulated generating units would be used more than they would under the base case, where some of the electrical generation shifts to the new, cleaner RNSPS units. For example, under the natural gas substitution case, SIP units would account for 32 percent of the electrical generation in the year 2000, whereas they would account for 25 percent under the base case. Thus, while sulfur dioxide emissions from SIP-regulated units would account for 67 percent (or 2.93 million tons) of the sulfur dioxide emitted in 2000 under the base case, under the natural gas case such emissions not only would be higher (3.05 million

Table ES-4
Sulfur Dioxide, Particulate, and Nitrogen Oxide Emissions, ORBES Region, Fuel Substitution and Conservation Emphasis Scenarios, Year 2000

	Sulfur Dioxide Emissions	Particulate Emissions	Nitrogen Oxide Emissions
		(millions of tons)	
1976	8.94	1.38	1.49
Base Case	4.35	0.19	2.00
Natural Gas Substitution	3.93	0.16	1.51
Nuclear Fuel Substitution	4.21	0.18	1.84
Conservation Emphasis	3.87	0.16	1.47

Note: Emission levels were not calculated for the alternative fuel substitution case.

tons) but also would account for more of the total emissions (78 percent of the 3.93 million tons emitted).

Particulate emissions also would be lower under all of the fuel substitution and conservation scenarios than they would be under the base case. However, again because of the expanded use of SIP units to generate electricity, these emissions would be only slightly lower than under the base case.

Utility nitrogen oxide emissions would not increase as much under the fuel substitution and conservation scenarios as under the base case (see table ES-4) since such emissions rise in proportion to increased generating capacity, and less generating capacity is added under all of the substitution and conservation scenarios than under any of the coal-dominated scenarios.

Although annual and episodic concentrations, crop losses, and emission-related mortality were not examined thoroughly under these fuel substitution and conservation scenarios, a few general observations can be made using the patterns developed under the coal-dominated scenario analyses.

CONCENTRATIONS. Since the magnitude of sulfur dioxide and particulate emission reductions consistently correlates with reductions in annual and episodic sulfur dioxide and particulate concentrations, and since all of the fuel substitution and conservation scenarios would reduce these emissions more than the base case would, concentrations should be lower in 2000 under any of the fuel substitution and conservation scenarios than under the base case. This observation is confirmed by calculations performed for the natural gas substitution case. Under the natural gas case, episodic sulfur dioxide and sulfate concentrations would be 25 and 15.6 percent lower, respectively, in the year 2000 than they would be under the base case in that year. Annual average concentrations would be about the same in 1985 and about 7 percent lower in 2000 than under the base case.

PHYSICAL CROP LOSSES. Similarly, physical crop losses in the year 2000 due to utility sulfur dioxide emissions should be lower under any of the fuel substitution and conservation cases than they would be under the base case. However, even under the base case such crop losses would represent less than 1 percent of the total regional yield.

It is the crop losses due to oxidants that these substitution and conservation scenarios should reduce the most. As will be recalled, increased utility nitrogen oxide emissions under the coal-dominated base case could contribute significantly by the year 2000 to crop losses. Thus, since the fuel substitution and conservation scenarios would result in utility nitrogen oxide emissions significantly or substantially lower than those under the base case, related crop losses also should be significantly to substantially lower under these scenarios.

MORTALITY. Finally, mortality related to air quality should decrease under all of these fuel substitution and conservation scenarios. An analysis of sulfate-related deaths under the natural gas substitution case bears out this observation. Under this case, cumulative sulfate deaths related to ORBES-region electrical generation would be 21 percent lower between 1975 and 2000 than they would be under the base case.

9.2 Economic Impacts Related to Air Quality Impacts

UTILITY COSTS. In terms of the monetary costs to the utilities and to the consumer for the lower emissions, all three of these substitution and conservation scenarios should result in lower cumulative pollution control costs and lower cumulative capital costs to install new coal-fired capacity than would the base case (see figure ES-15). These reductions are the direct result of decreased coal-fired generating capacity under all of these scenarios. However, when the costs of installing nuclear-fueled capacity are added, the nuclear fuel substitution case results in total costs about 10 percent higher than the total costs under the base case. The nuclear substitution case would result in these higher costs because the cost of building a nuclear-fueled plant is approximately 20 percent higher than the cost of building a comparable coal-fired plant.

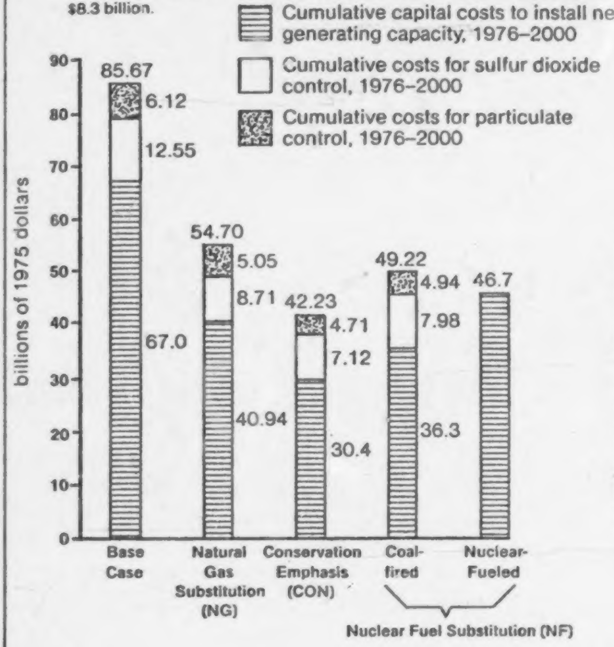
CONSUMER COSTS. Consumer costs were calculated only for the natural gas substitution case. Thus, the exact economic benefits for the consumer of reduced pollution control costs and of reduced capital costs are unknown for the other fuel substitution and conservation scenarios. Under the natural gas substitution case, however, the total revenues collected from consumers between 1976 and 2000 would be lower (by about 26 percent) than the total revenues collected under the base case during the same years. Yet the actual price of electricity in 2000 under the former case would be only 0.2 percent lower in 2000 than it would be under the coal-dominated base case. The reason for this similarity in the year 2000 can be traced to the fact that similar electricity demand growth rates were assumed for these two scenarios between 1985 and 2000.

9.3 Other Impacts Related to Expanded Capacity

HEALTH AND LAND. As a result of decreased generating capacity, decreased coal production, and decreased utility coal consumption under the fuel substitution and conservation scenarios, fewer health impacts related to coal mining, coal processing, and coal transport would occur than would occur under the coal-dominated scenarios. Similarly, land conversion would be lower under these substitution and conservation options than under base case. However, even under the base case, land conversion would represent less than 1 percent of regional acreage, although some state portions would be more affected than others.

Figure ES-15
Cumulative Capital Costs, Base Case, Fuel Substitution Scenarios, and Conservation Emphasis Scenario, 1976–2000

Note: The same nuclear capacity was assumed under all scenarios but the nuclear fuel substitution case. For all scenarios but the nuclear case, cumulative capital costs for nuclear-fueled capacity were $8.3 billion.



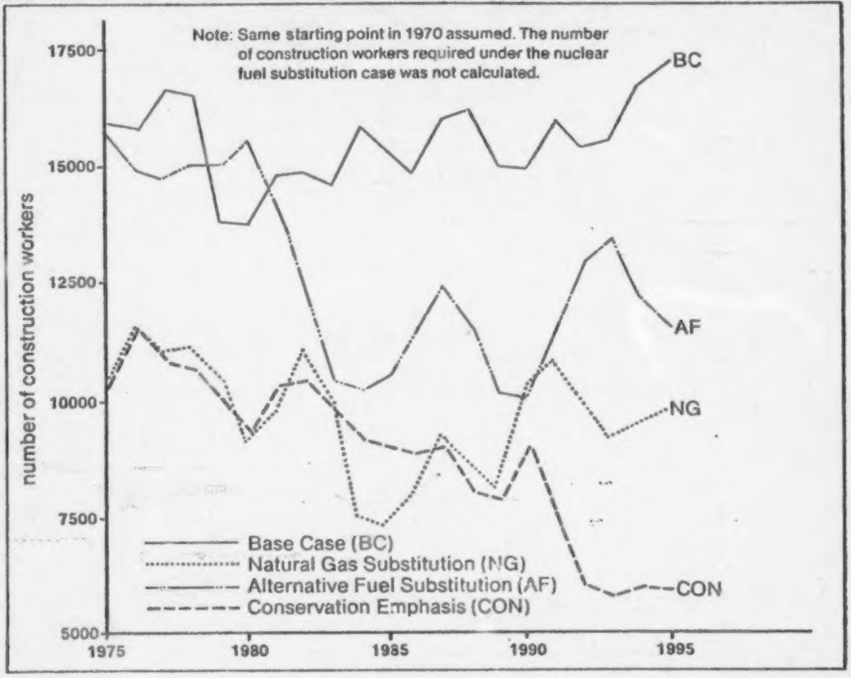
Cumulative sulfur dioxide and particulate control costs

Scenario	Costs billion $	% total costs
BC	18.67	21.8
NG	13.76	25.1
CON	11.83	28.0
NF	12.92	26.2

EMPLOYMENT. Since coal-fired power plant construction and operation would not increase rapidly under the fuel substitution and conservation scenarios, neither would related employment under any of these cases. Compared to the coal-dominated base case, for example, the number of construction and operation workers needed would be much lower (see figure ES-16). However, employment needs related to the increased use of natural gas, nuclear power, or alternative fuels were not calculated; in fact, these needs could compensate for the lower demand for coal-fired power plant workers.

Again because fewer coal-fired generating facilities are sited and because growth is lower in all sectors, less coal would be needed under all of

Figure ES-16
Construction Workers, Base Case, Fuel Substitution Scenarios, and Conservation Emphasis Scenario, 1975–95



Note: Same starting point in 1970 assumed. The number of construction workers required under the nuclear fuel substitution case was not calculated.

the fuel substitution and conservation scenarios than under the coal-dominated cases, although such coal demand would be somewhat higher than at present (see table ES-1). Thus, coal-mining employment for all purposes would increase from current levels at a slower rate under the substitution and conservation scenarios. Moreover, if county-level population increases should exceed the employment increases, negative county-level impacts that might have been avoided under coal-dominated scenarios might be felt under the substitution and conservation cases.

WATER. Regional water quality impacts would be about the same under both the fuel substitution and conservation scenarios and the coal-dominated scenarios. In fact, no changes would be registered in base case protection levels and base case aquatic habitat impacts for any river under any of the fuel substitution and conservation scenarios. This across-the-board similarity, as discussed previously (see sec. 6.3), results primarily from high background concentrations alone or in conjunction with municipal and industrial consumption. In comparison, power plant consumption would have only an incremental impact on most of the streams under all scenarios.

10. INSTITUTIONAL CONSIDERATIONS: NUCLEAR ENERGY, ALTERNATIVE FUELS, AND CONSERVATION

It is considered unlikely that either nuclear energy or alternative fuels will contribute substantially to energy supplies in the ORBES region or the nation, at least by the end of this century. One reason is that a major increase in the proportion of electricity generated by nuclear fuels is not expected to occur in the coal-dominated ORBES region. A second reason is that a major shift to alternative fuels would require more extensive technological and institutional changes than are considered possible in the next 20 years. However, conservation could make significant inroads by the end of the century. Conservation would require improvements in end-use efficiencies and changes in lifestyle, but no radically new technologies. (Existing institutional mechanisms would be adequate to handle a major increase in the use of natural gas.)

NUCLEAR ENERGY. Within the ORBES region, opposition to the use of nuclear energy for electrical generation is particularly visible in Kentucky, Pennsylvania, and West Virginia. Among the factors leading to this opposition are the doctrine of federal preemption, controversy over the health effects of low- and high-level radiation, and growing dissatisfaction with the economics of nuclear energy.

With regard to preemption, the central, unresolved question is whether a state may legally pass legislation to control the placement of nuclear facilities or the transportation or storage of nuclear materials within its borders. With regard to the economics of nuclear-fueled generation, nuclear-fueled units are slightly more expensive to build than are coal-fired units under the current fiscal and regulatory schemes prevalent in the ORBES region. In addition, at least in a representative portion of the region, the cost advantage of coal would be substantially greater without present federal tax and other fiscal policies that favor capital-intensive production (including the nuclear industry).

ALTERNATIVE FUELS. The alternative fuels case considers the partial substitution of direct and indirect solar energy processes for coal-fired electrical generation in the ORBES region.

Solar Energy. Three broad groups of institutional issues are associated with the introduction of solar energy: legal and physical access to sunlight, integration with existing energy infrastructures and institutions, and government program implementation and management.

The solar access barrier stems from the basic orientation of real property law toward the development of land. That is, the potential investor in a solar energy system is not guaranteed permanent access to sunlight. Changes in nuisance law, zoning, solar easements, and restrictive covenants offer possible remedies. At present, limited solar access laws have been enacted in Illinois and Ohio.

The integration of solar energy systems into existing energy infrastructures and systems raises a number of issues, including (1) the rates paid by utilities for power sold to the grid as well as for back-up power and other services provided to on-site generators, (2) the legal status of on-site generators, (3) the financing and ownership of dispersed capacity, and (4) utility management problems and perceived risks. The first two issues are dealt with in part by the Public Utility Regulatory Practices Act of 1978 (PURPA), part of the National Energy Act. The third issue is handled somewhat by the National Energy Conservation Policy Act. For the fourth issue to be dealt with, utility management techniques would have to change to accommodate a transition to dispersed capacity.

Finally, the present management of government solar programs is hampered by a number of deficiencies within the Department of Energy's Conservation and Solar Energy Programs, such as a constantly changing organizational structure.

Wind Energy. As with solar and other dispersed electric energy systems, the widespread introduction of wind energy conversion systems would raise a number of legal and institutional issues. These include financing, siting, tort liability, and environmental problems.

Biomass. Although biomass is a promising energy source for the ORBES region, its use on a wide scale also would entail the solution of unresolved institutional questions. An issue common to all bioenergy sources is the need to develop programs to provide information and technical assistance to bioenergy users. Also needed is the establishment of reliable supply infrastructures for direct energy uses of biomass resources. In both public and private operations, long-range energy and resource planning and proper resource management would have to take place. Institutional changes would be required to link bioenergy to conventional energy supply infrastructures and users. For example, where biomass is used to produce electricity, provisions must be made to sell surplus power to the grid at equitable rates and to supply back-up power to producers of bio-electricity. Finally, federal administration of bioenergy research, development, and implementation would have to be improved.

Each form of biomass entails additional issues. The primary institutional issue associated with the use of wood as energy is the management and care of the resource base, that is, forest lands. The primary institutional issues associated with intensive agricultural production for energy are the integration of energy demand for crops into existing markets and the potential for environmental damage. The use of municipal solid wastes for energy raises institutional issues related to the removal of barriers to resource recovery.

CONSERVATION. Only one conservation measure--cogeneration--was quantified for use in an ORBES scenario. Economic factors are the primary institutional considerations associated with the introduction of cogeneration by industries, notably the rate of return on investment in cogeneration technology. The most important cost consideration is the savings realized from cogeneration when compared with the alternative costs of separate operations for in-house steam production and purchased electricity. Other concerns are effects on the environment and potential regulatory constraints.

11. CONCLUDING NOTE

One important insight gained by the ORBES researchers is that the study region, part of which is known popularly as the Ohio River valley, is far more diverse than they had suspected and probably more so than most public officials realize. Failure to recognize this diversity most certainly will doom to failure any attempt at basinwide institutional innovations. There is indeed balkanization within the ORBES region, and with a continued emphasis on coal, ideological divisions probably will become more pronounced.

The local and long-range transboundary movement of air pollutants across state lines is the single issue within the broad context of continued (and perhaps increased) reliance on coal that could produce the most conflict. Since ORBES began in 1976, this issue has gained increased attention in the region. It affects employment levels in the coal-mining industry as well as in industry in general. It triggers emotions that are easily translated into political controversy.

But many of the ORBES researchers--air pollution experts, economists, lawyers, political scientists, and others--believe that institutional mechanisms can be devised that will permit the region to enjoy the benefits of both reasonably clean air and a degree of economic growth. The creation of such mechanisms will require the highest technological competence, as well as social and political imagination. If there is any single finding of the Ohio River Basin Energy Study, it is that steps toward both clean air and economic growth in the region can be taken only if ways can be found to unite the various factions. Many residents of the region have recognized this reality, but they remain separated by ideology. Some believe that the steps should be initiated by government, while others favor action within the private sector. It is not the responsibility of ORBES researchers to recommend which path should be followed. But it is our responsibility to warn that inaction could result in economic stagnation and accompanying social problems capable of draining much-needed vitality from the region and from the nation at-large.

Mr. **Scheuer.** I would ask unanimous consent that it hold the record open for 10 or 12 days, pending receipt of that information.

Mr. **Sensenbrenner.** I believe that would be very useful because I am sure public officials in New York State are not unlike those in Wisconsin and elsewhere in that one of the repeated complaints we hear from our constituents is the steadily increasing cost of utility service, particularly how high electric bills go, and I think the easiest way to kill any responsible action to curtail acid rain is to float around figures that would double the cost of electricity to people who live in the Ohio River Valley. I think the information you would supply us would probably dispel that argument.

Mr. **Fink.** Except I most respectfully suggest the cost of doing this by the Federal Government won't cost the people in the Ohio Valley anything. I don't think you would see an immediate kilowatt increase on anyone's electric bill in the Ohio Valley if the cost was borne through a Federal program.

Mr. **Sensenbrenner.** I don't think that that kind of Federal program stands much of a chance of passage through the Congress because I am sure that there will be some people from New York who represent your State in the Congress who will say, "We have paid for this in terms of our own higher electric utility bills, and why should we ask our taxpayers not only to pay for cleaning up New York's plants through higher electric bills, but also through Federal taxes cleaning up Ohio's plants?" I really don't see that kind of a program being passed by the Congress.

I do see in the revision of the Clean Air Act some of the suggestions being incorporated in, so there would be a mandate that the people who are doing the emissions clean up their act, just as electric utilities in other parts of the country have done.

I yield to the gentleman from New York.

Mr. **Mitchell.** I was reading some things about acid rain recently. I have something given us by the committee going to the cost of the program. It says the cost of installing scrubber systems as these new plants are built won't be cheap, $10 billion, capital cost.

Then it talks about pollution controls, which are a small price to pay. They would increase electric utility annual revenue requirements by only 2 percent, which in 1995 will translate into only $12.20 higher monthly electric bills for residential consumers.

Indirect costs to these consumers passed on by industrial electric users would add another $12.20 per family by 1995. That is about $2.40 a month, according to this EPA billing, which isn't much.

Mr. **Fink.** Using the latest state of the art scrubbers, which is the most expensive way.

Mr. **Sensenbrenner.** I yield back the balance of my time.

Mr. **Scheuer.** Thank you very much, Congressman.

Congressman Gregg?

Mr. **Gregg.** I would also like to thank you for proceeding with this hearing up here. It is an honor to be in Dave Martin's district. Dave and I came into Congress together. There were 54 new Members in our class, and we have had a reasonable effect on our Congress, and one of the leaders has been Dave Martin.

Mr. **Scheuer.** I would say you have had an almost unreasonable effect on the Congress.

Mr. **Gregg**. I would also like to point out this is an interesting part of the country. I haven't had a chance to be over here before. As with any part of the country, I am sure you people like to get around and see other parts of the country.

I would invite you over to New Hampshire and the White Mountains, which is also pretty country being affected by acid rain.

I was very impressed with the speaker's presentation. It is precise and to the point, and that is nice to hear.

One of the questions which I had for the speaker is, What sort of help do you anticipate New York is going to give Members of the Congress in lobbying and producing a package here?

Mr. **Fink**. Well, Congressman, that is an interesting question. I guess we can threaten them, but we normally don't have to. Our congressional delegation we find from across the State, regardless of party or region, when there have been issues affecting the State of New York or parts of the State of New York, they are banded together in an attempt to solve those problems.

As for the State government of the State of New York, I can tell you they maintain an office in Washington. I have recently become chairman of a National Conference of State Democratic Legislative Leaders, and I am involved in a conference of State leaders from both parties across the Nation.

We are convinced that we, as State officials, must do a greater degree of networking of interest, and I maintain a staff in Washington that spends a great deal of time networking in terms of the various States affected by various problems.

We have been involved in a proposal that Senator Moynihan has put in for us called the Fair Deal amendment, where we would hope some day those States that found it necessary to put gross receipts taxes on the sale of petroleum products would allow the oil companies to deduct from the windfall profits tax the amount they pay to the States, just as there are States in the Union that deduct from the windfall profits tax the amount of severance taxes they pay to the States in which they are pumped out of the ground.

So we are on an ongoing basis of networking States and local governments in an attempt to influence our congressional delegation.

In terms of our support, or the State of New York or the assembly of the State of New York, we would be prepared to network not only with our own congressional delegation, but congressional delegations from other parts of the Nation, in an attempt to gain some support in the House of Representatives for proposals.

Mr. **Gregg**. I appreciate that. I am not anticipating the New York delegation is going to be anything but supportive of the issues which try to address acid rain. We have to be pragmatic about this as a very practical matter.

The issue of acid rain has evolved into a regional issue. You do have a strong movement in the House to deregulate and to change the Clean Air Act, and there is going to be a confrontation.

Mr. **Fink**. Mr. Gregg, I would make an observation. I am not familiar with the inner workings of the House of Representatives and how you people from regions get together or not get together.

You just made a statement a few moments ago that you were a good friend of Mr. Martin and you came to the House of Representatives together. Well, Mr. Martin and I were and still are colleagues and good friends because we served for a number of years together in the assembly of the State of New York.

He represents a rural district in the northernmost part of the State of New York—and did then—and I represented a most urban district in the most populous city in the State of New York.

Yet when Mr. Martin needed some support for a bill banning a State regulation having to do with covered dish dinners in communities in rural areas of the State of New York, he knew exactly what buttons to press to get people like me to support him.

I submit to you that one of the things I have seen people like Mr. Martin do very effectively in our house, and before him Mr. Solomon, was that they were able to build coalitions and tradeoffs. Mr. Martin would not have voted for a bill affecting my community if I didn't vote for a bill affecting his community.

I believe that the congressional delegations from the Northeast-Midwest have never, as a bloc, done the things they should have appropriately done in terms of banding together in the 17 Northern and Midwestern States, including Missouri as one of them.

There are a majority of Members of the House of Representatives in those States—that is in the next reapportionment—and it is my opinion, sir, that the Members of the House of Representatives from those regions of our Nation have never banded together and played hardball politics down in Washington with the conferers from the Sun Belt, the Midwest, and the Far West.

I know little of the workings of the House of Representatives, so I can't tell you how to accomplish that. I am just giving you a perception as a lay person who reads newspapers.

Mr. GREGG. I think I may have touched a point which interests the Speaker.

Mr. SENSENBRENNER. Would the gentleman yield?

Mr. GREGG. I yield.

Mr. SENSENBRENNER. Mr. Speaker, I happened to serve as a member of the board of directors of the Northeast-Midwest Coalition, and I think I can answer your question, having served in that capacity for about 2½ years.

The reason that the Northeast and Midwest have not gotten together to wage war successfully against the Sun Belt is that there are far too many Members of Congress on both sides of the aisle from the Northeast and Midwest who want to use that coalition for partisan "one-upsmanship" games rather than for getting about the issues where the Republicans and the Democrats are on the other side, and confining one's specific efforts to the issues which should transcend party lines.

That is why the Northeast-Midwest Coalition has not been as effective as you and I may want it to be.

Mr. FINK. Shame on all of them who have done that, Congressman.

Mr. GREGG. If I can reclaim my time and get back to acid rain, as I see it—and the reason I raise the question—this whole issue is going to flounder in the Congress unless we work as a team. That is the point I was trying to make.

It is great to have the response the speaker made, because I think that shows the commitment of New York. We just have to attract a few more States into the process and hopefully we can address the issue effectively.

Mr. SCHEUER. Speaker Fink, you mentioned the networking you are engaged in with other State legislators across the country, and you mention the great responsibility you have as chairman of a corpus of Democratic State legislators around the country. This is truly symbolic of the tremendous national leadership role you are playing. Do you find their level of consciousness on the whole question of acid rain has been raised, that they are conscious of this problem, and they are ready and eager to take collective action on a State level?

Mr. FINK. We have done a degree of networking with the legislative leadership of the houses of all New England States, irrespective of party. There has been a clear willingness to work as a group together with our respective congressional delegations.

Mr. SCHEUER. Very good.

I might say this tremendous turnout here of Congressmen is symbolic of the priority position that acid rain takes in our Congress now. I am somewhat embarrassed that I am the only Democrat here, but this certainly shows the concern of our Republican colleagues.

Perhaps the tremendous turnout of Republicans is caused by the fact that acid rain superficially at least seems to be a rural problem, since it affects grazing lands, farmlands, lakes, streams, forest growth, and so forth. Therefore, you have essentially nonurban Members here.

I am convinced urban Congressmen also see this as a national problem. I think when the time comes to vote, you are going to see a reaching across of party lines. I think you are going to see a great many Republican Members voting for intelligent cost effective programs for acid rain amelioration and for R. & D. on acid rain solutions in the years to come.

I might say that, due in large part to the work of this committee—and I will give specific credit to Congressman Carney—we did get the administration to up its research efforts on acid rain from $12 million to $20 million. So at least the administration is headed in the right direction there.

Let me call upon Congressman Solomon.

Mr. SOLOMON. Thank you, Mr. Chairman.

I have no questions because we have really taken up enough of the speaker's time. I for one have taken up enough of his time over the years to last for a lifetime, I am sure. I have but two observations.

Mr. Speaker, the interworkings of the House of Representatives, you said you didn't know what it was like. It is identical to the New York State Assembly. Identical.

Mr. SCHEUER. Your worst fears are compounded.

Mr. SOLOMON. Second, the bipartisan approach you are urging so much I am sure is also going to carry off in the New York State Assembly when we get into reapportionment.

Mr. FINK. No question about it. No problems with the Republicans in the Senate.

Mr. **Solomon**. Let me commend you on the specificity of your testimony. We really appreciate your coming. You were specific, and we appreciate your taking the time.

Mr. **Scheuer**. Congressman Mitchell?

Mr. **Mitchell**. Thank you, Mr. Chairman.

I have no question either, but I would like to make some observations.

First, I commend the speaker on his statement. It was fine.

Let me say I agree that primary responsibility lies with the Federal Government, but we need some help from the State, too. I was talking with some State department of environmental conservation people who say that the rate at which we are studying our lakes in the Adirondacks, it will take us 20 years to test them all.

We have only tested 800-some lakes. They estimate if the State would come up with about $340,000 additional a year, we could complete the study in 3 or 4 years and really know the extent of the problem.

I know you can't do it alone, but I would urge the State legislature to help in that regard so we really know the dimensions of the problem.

Second, you made an observation about nuclear and coal energy. I would like to add to that that where we have the technology to solve the acid rain problem we still haven't the technology to solve the nuclear waste problem, so I would tend to agree to some extent with your remarks in that area.

As for the Northeast-Midwest Coalition, I would disagree. I was one of the founders and the chairman of the first task force. In fact, we sort of set the pattern. I have been disappointed at the lack of participation of Members of Congress from the Northeastern-Midwestern States.

Your observations do demonstrate perfectly that you really don't know how Congress works. I disagree with my friend, Gerry Solomon. It is different than the State legislature in many regards.

One very great similarity—I think this is what Gerry was referring to—the battle or the confrontation between the Northeast-Midwest Coalition and the Sun Belt is very similar to the upstate-downstate battle that I am sure is alive and well, still, as it was when I was in the legislature, so that will help you understand the problem more.

You can build some bridges. We have. We have made some gains. Not nearly as many as we would like to, but whatever we gain, they lose, just as whatever New York City gains, upstate loses.

We can talk about this at a later time.

Mr. **Scheuer**. Congressman Martin?

Mr. **Martin**. Briefly, Stanley, your testimony was a nostalgic trip for me in many ways. Since I had a task force here on nuclear power, we have been everywhere from Buffalo to New York City on that issue. I appreciate your concern and interest in this area.

I think you really hit the nail on the head when you professed not to understand the workings of Congress. You explained, I think as accurately as anyone could, the name of the game. The lessons I learned from you in Albany are also true in Washington.

The name of the game is to get those 230 votes on rational amendments to the Clean Air Act that are arguably cost effective and also ameliorate the problems we face here in the Northeast.

I thank you and salute you for your cooperation with us on this issue and other issues. In the short term I have been in Congress, I have really appreciated it. I think we can resolve this problem, as we have resolved other problems in the past.

Thank you, and thank you for your time.

Mr. **Scheuer**. Thank you, Dave.

Speaker Fink, I think you have seen a demonstration of the bipartisan concern on Capitol Hill with this problem of acid rain, and the solid concern that is evidenced by Republican Members of Congress.

I hope the bipartisan coalition will be working hard to support the solutions when they come up, both in terms of R. & D. flowing out of our committee, and in terms of the specific national programs that will flow from the rewrite of the Clean Air Act earlier next year.

I congratulate you on your leadership with New York State and nationally, and I look forward to working with you. I am sure this group will be in touch with you and will be looking for your counsel and advice in the future.

Thank you very much for your attention.

Mr. **Fink**. Gentlemen, I thank all of you. It has been an honor and a privilege to have the opportunity to testify before you, and I thank you for coming to New York State.

Mr. **Scheuer**. Due to the excellence of Speaker Fink's testimony, we took more time than we had programed, so we will have to maintain a rigorous timetable for the rest of the morning.

We are going to limit each speaker, including questions and answers, to 15 minutes, so we would hope that each speaker would restrict his written or spoken testimony to 5, 6, or 7 minutes at the most so we will have at least 7 or 8 minutes for questions and answers.

Mr. **Sensenbrenner**. May I request the witnesses both this morning and this afternoon to summarize the testimony which they have submitted and we will put the complete testimony in the record.

Mr. **Scheuer**. That is exactly what we are doing now. Of course, all of their testimony will be printed in full at the point in the record at which they are testifying. We are now in the process of requesting them to summarize their testimony.

We will proceed first with Mr. Peter Lanahan, first deputy commissioner of the New York State Department of Environmental Conservation.

We are delighted to have you here, Mr. Lanahan. We will be happy to hear you.

STATEMENT OF M. PETER LANAHAN, FIRST DEPUTY COMMISSIONER, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Mr. **Lanahan**. Mr. Chairman, it is a pleasure to be here. Commissioner Bob Flacke, who is the head of our department, would have been here himself, however, being an Adirondacker and having a wife who is involved in the tourism business, they took a week off in our touring State and, as a matter of fact, some of the surrounding States looking at the natural resources. This is an excellent choice for a hearing of this nature because it was right here in this Adirondack region where New York State first documented its problem of acid rain. You heard Speaker Fink refer to the fact we have 737,000 acres of lakes in the Adirondacks, with a pH lower than 6. That puts them on our endangered list. We have another 10,000 acres which are below a pH of 5, which puts them on a critical list. Over the past 2 years we have done some further surveys of streams, which indicate that in the spring when the snow pack melts, the acid rain situation in our streams becomes critical.

I want to point out quickly, that while we have a problem here with acid rain, the situation is not all one of gloom and doom. I will tell you why I want to point this out in a minute. We still have some viable fisheries here in the Adirondacks, and we have some very good ones. The Atlantic salmon from Lake Champlain are now pooled in the Polecat River, only a 45-minute drive from here. People are catching them. The lake trout fishery in Lake Placid right here is excellent. We took a 19-pound landlocked salmon out of Lake George this year. So we are doing some things and they are working. I don't want to kid you; we do have a problem.

The reason I want to point out that the fisheries in the Adirondacks, in our larger lakes particularly, remain viable is because this is a region of the State which sometimes experiences unemployment in excess of 16 percent, and I don't want anybody to leave here today thinking this isn't still a good place to come for a vacation and it is still a good place to come fishing.

However, there is a problem. I would like to see if I could tell you a little about it today, and what we are doing about it.

Someone asked before, What is the economic impact of the acid rain problem? The New England River Basin Commission, of which we are a member, has done a study and estimates that the cost is in excess of $500 million, and that includes damage to structures and cities from acid rain as well as damage to our natural resources.

New York State is about to embark on a study which would, I think, respond to the David Stockman question of what does it cost. We intend to document not only the impact on tourism but the impact on our industrial base as well. Here I am referring to the fact that we believe there are industries who do not come to New York because our airshed is impacted by transported pollution from out of State. We want to document all this. We consider this necessary applied research that can help you bring the ammunition to our colleagues to help solve the problem.

We are documenting the destruction and we think that is important. We are going to continue our field surveys which I mentioned a minute ago, studying our lakes to see where the pH is becoming most critical. Next month we are convening here in the Adirondacks a conference of scientists and people from other State agencies to outline a long-term research program. When that long-term research program is put together, we will forward it to you.

I want to point out very quickly that I don't think this is entirely a scientific problem. The people who cry loudest and longest for most research, or for more research, seem to me to be the representatives of the utility industry, the people from the Midwest, and the coal interests. When you go to a conference as we have and invite people to come to New York, the industry people tell us, "Look, we don't know what causes this, neither do you. And we have to do more research before we try to solve it."

We think we know what some of the solutions are right now. We think they can put into action and we would ask you to help us do that. Our specific proposals are, coal washing at the mine mouth for coal which is above 3 percent sulfur. We think this can reduce the sulfur loading which reaches New York State by as much as 25 percent. We are also looking for national emission standards on sulfates when the Clean Air Act is revised. We think the national emission standard will, again, reduce the amount of sulfur which reaches New York State.

We are looking for, as Speaker Fink suggested, reasonable technology to be put on existing powerplants. We do want more research but we want research that will be applied to solving the problem. Document the health effects of inhalable small particulates. Document the other impacts on drinking water but at the same time move forward toward solving the problem.

I think there is one short story I could tell you that would serve as evidence of what I am saying. During the previous administration in Washington, we established a coalition of surrounding State environmental commissioners, and we went to Washington to meet with Administrator Costle to describe this problem, and I met with him. I said—

> You know there is an election coming up and we are going to be asked about this, the people in the Adirondacks are asking about it. What can you do to help us?
>
> This is a political problem and even the miners in the Midwest say they don't want a solution. You are saying you do want it. The answer is to keep the heat on.

We are going to keep the heat on. We think that is where the problem will be solved. We want to give you people the ammunition that you need to make the technical case. That is where the research is needed, and again we thank you for coming to New York State and listening to us. We will be supplying you with more information after our conference next month. Thank you.

[The prepared statement of Mr. Lanahan follows:]

STATEMENT OF M. PETER LANAHAN, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, SEPTEMBER 18, 1981

Mr. Chairman, I am Peter Lanahan, First Deputy Commissioner of the New York State Department of Environmental Conservation, representing Commissioner Flacke, who regrets very much that he was unable to attend in person, I would like to thank you for this opportunity to speak with you about acid rain, a problem of considerable concern to New York State. First, I wish to commend you on choosing this site for the hearing. It is most appropriate. For citizens in this part of our state are very aware of the consequences of this most serious problem: acid precipitation and the long range transport of pollution.

When Commissioner Flacke presented testimony before your committee on May 28 he provided you with "The New York State Position Paper on the Clean Air Act" for entry into your official records. Not only will I reemphasize what commissioner Flacke had to say then, but I will also bring you up to date on recent developments in New York.

Acid precipitation is slowly taking its toll here in New York and, indeed throughout the Northeastern United States and Canada. Wilderness mountain lakes and ponds, productive farm land, agricultural crops, soils and building—all of these and, perhaps, more may be falling prey to this subtle form of air pollution.

Acid precipitation does not produce immediate, dramatic effects. There are, thus far, no dead bodies or vast acreages of waste-lands to attest to the effects of this insidious form of air pollution. There are, however, hundreds of lakes in New York State which no longer support diverse aquatic ecosystems, Including sport fish populations. These lakes and streams were once an important natural heritage, a source of recreation and spiritual uplifting for many thousands of citizens. The loss of these resources is serious, but even more disturbing is the fact that many other lakes are beginning to exhibit changes, with populations of some fish gone and others on their way to disappearing. We fear that this present, and spreading, deterioration of our natural resources is only the first indication of subtle widespread damage from nearly invisible air pollutants.

Acid rain is a nationwide, even a worldwide, problem, of growing impact. The New York State Department of Environmental Conservation recognized the possible significance of acid precipitation to fishery resources in the Adirondack region early in the 1970s. Since 1975 the Department has identified 468 lakes and ponds, comprising over 73,000 acres in the Adirondack region of New York, which chronically exhibit pH condition below 5. This represents over 25 percent of the ponded water in the Adirondacks. More than 200 lakes (comprising over 10,000 acres) exhibit summer pH values of less than 5 and are generally unable to maintain any type of either native or stocked sport fish populations. Surveys over the last two years show that streams are also being affected.

Most fish species, many aquatic plants, and invertebrates cannot tolerate pH levels below pH 5. Existing biological communities are disrupted at that level and metabolic and reproductive activites in fish populations are often upset, to a point where whole populations are eliminated. This has happened and is still happening in our Adirondack lakes.

Although data on other effects are still being collected and analyzed, acid rain is also thought to be adversely affecting terrestrial ecosystems. visibility and, perhaps man himself.

In fact, a recent report by the New England River Basins Commission pegs the yearly cost at $250 to $500 million for damage to both aquatic and terrestrial ecosystems in New York and New England. This includes losses to recreational fishing and related tourism; drinking water supply treatment; lumber, paper and related industries: crops and vegetation, and to manmade materials such as buildings and monuments.

These losses are conservative, says the commission report, and could be as high at $2.5 billion per year, if other secondary and human costs are considered.

Studies also indicate that continued acid deposition is a threat to forest productivity in the Northeast, a potential source of damage to New York's $2 billion small crop agriculture base, as well as to other important segments of our economy.

Researchers have shown that the deterioration of masonry occurs when acidic substance dissolve such materials as limestone and marbles. Acid also destroys sculptured details, as seen by the hieroglyphic deterioration on Cleopatra's Needle, in New York's Central Park, and the Statue of Liberty in New York Harbor.

The New England Commission estimates at $13 billion the annual cost of degradation of materials—mortar, stone, metal, concrete, textiles, paper, paint and leather—in the eastern part of the nation.

Another adverse effect of acid precipitation is reduced visibility in the Northest. Fine particulates—precursors to acid rain—scatter and absorb light. The most dramatic reduction in visibility occurs in the summer when reduction of 25-60 percent in the Northeast has been documented.

Of all areas of concern, human health is probably the least well understood but, at the same time, of utmost concern to us all. Identifying aquatic and terrestrial losses due to acid rain is important, to be sure, but it can serve also as an omen of a potential danger for humans.

Documenting this destruction is important. However, understanding the total acid precipitation problem requires intensive study to probe the underlying causes and develop workable solutions.

There is generally strong scientific consensus that atmopsheric sulfates and nitrates are prime contributors to acid precipitation. These compounds may be transported many miles in the upper atmosphere, before they washed out as acid rain.

Although we do not understand fully the sources or mechanisms by which acid precipitation is formed, both source and effect can be mitigated. Atmospheric emissions of sulfur dioxide can be reduced by requiring low sulfur fuel, by scrubbing emissions from power plants, by washing or cleaning sulful from coal, or through combinations of these techniques. We do not see any one of these strategies as being a complete solution, but we do believe that coal washing should be implemented now and would be the most cost-effective for existing facilities. Scrubbing may be a reasonable option for some existing plants, but probably not for all.

Stationary combustion sources are major contributors to acid precipitation through nitrogen oxide emission. Reduction of stationary source emissions is best accomplished through modification to design of the burning equipment so that staged combustion or other techniques can reduce the formation of nitrogen oxides.

Under Governor Carey's leadership, the DEC has pioneered in efforts to seek a federal solution to this nationwide problem. New York State has petitioned the U.S. Environmental Protection Agency in an effort to convince that agency that the problem is interstate and cannot be solved by any one state alone. New York has formed a coalition with several other Northeast and Mid-Atlantic states to push for federal action.

New York has proposed several modifications to the Federal Clean Air Act. These changes, which are now before the Congress, would make the Act more responsive to the needs of the Northeast, address acid rain from a national perspective, and be a major step towards a solution.

New York's Senior Senator Daniel Patrick Moynihan has won congressional authorization for a national research program to explore and document the problem over the next decade. We hope that this program can be accomplished sooner, within the next five years. We believe that, while this research program is underway, the nation needs: a national coal washing program to require the cleaning of coal with a sulfur content greater than three percent; retrofitting existing power plants for staged combustion to cut down on nitrogen oxide emission, and studying the feasibility of establishing national emission standards for sulfates. These actions alone would be major steps in reducing sulfur and nitrogen emissions to the atmosphere, and thereby in curbing acid deposition.

The other significant source of nitrogen oxides is the motor vehicle. We are dismayed that a strong move is underway to amend the Clean Air Act to allow increased nitrogen oxide emissions from motor vehicles. It is important not to lose the regulatory headway we have made against this component of acid rain.

As these issues are debated in the Congress, New York will continue several other efforts to combat the problem. On a short-term basis, the state's lake liming program will be continued to preserve fish populations threatened by acid rain.

Natural resources studies, including field surveys, inventories, long-term monitoring and efforts to develop acid-tolerant species, are an important part of New York's acid rain response.

Air pollution research is yet another, integral, part of understanding the acid precipitation problem. Studies detailing the effects, sources, transport mechanisms and mitigation factors at both the source and receptor are very important if we wish to solve this problem.

For this reason, the Department of Environmental Conservation is planning a three-day research management conference in mid-October at the Huntington Forest, here in the Adirondacks. The goal of this conference will be to determine New York State's research needs in the area of acid precipitation. The conference will be broad in scope, covering most facets of the problem such as atmospheric chemistry; pollutant transport and deposition; and aquatic, terrestrial and health effects.

A draft report on New York's research needs is expected to help New York State in planning its own research and made available to others interested in acid precipitation research, including Federal agencies and Congressional Committees. As soon as the report of this panel is available, we will send copies to this Committee.

Again, thank you for the opportunity to present our views about this significant problem. We welcome your interest in understanding the complexities of air pollution and its subtle effects on our citizens and their environment. We look forward to working with you to find solutions that will allow science and technology to continue to benefit mankind with minimal adverse consequences.

Mr. SCHEUER. Thank you very much.

Congressman Carney.

Mr. CARNEY. Thank you, Mr. Chairman.

Mr. Lanahan, are you aware of how much Federal money comes into New York State on acid rain?

Mr. Lanahan. How much Federal money comes into New York State on acid rain? Actually, to our department level for acid rain research—very little. Most of the research money we have put into the problem comes out of State money. The fisheries work that we do is entirely or nearly entirely State money. The economic study that we intend to accomplish we hope to share with some other State agencies. There may be some Federal money from various sources coming into that, but the amount of money coming into the State from Federal sources is very little. As a matter of fact, we are facing, as you might imagine, severe cutbacks across the board in all of our programs because they are supported largely with Federal funds.

Mr. Carney. They are supported with Federal funds, so there would be a cutback.

Mr. Lanahan. That is correct.

Mr. Carney. We in New York State, are participating right now with Federal dollars on R. & D. on acid rain?

Mr. Lanahan. To some extent but not nearly enough.

Mr. Carney. It is my belief it is about 20 percent of the total Federal commitment on acid rain; about 20 percent of that total commitment comes to New York State.

Mr. Lanahan. It may come to New York State. It does not come to the department of environmental conservation.

Mr. Carney. I think that is a reflection on the fact that we have some nine universities and facilities, that it comes to New York.

I just want to clarify that because we are trying to find a solution to the problem and the best place to do it is in the impacted areas. I wouldn't want the perception to be that the Federal Govenment is ignoring New York State. They received an enormous amount of commitment to date. I believe the commitment should be increased and I would be in total agreement with you on that, but New York State is the recipient of a great share of the Federal Government's program on acid rain.

Mr. Lanahan. I didn't mean to leave you with the impression that I thought there was no money coming here. I was speaking from our department's viewpoint. Senator Moynihan, as you know, has established a research program which we think will be very helpful. There are people here from the State university, as you point out, who benefit from Federal funds on acid rain research. As a matter of fact, the original documentation of the problem was done by Cornell University, working with our people, again under a Federal grant. That was 5 or 6 years ago.

Mr. Carney. Mr. Chairman, I have had an opportunity to read Mr. Lanahan's testimony in full, but in the interests of brevity, I would yield to my other colleagues for quetions and I would, in conclusion, like to thank him for taking time from his busy schedule to come here.

Mr. Scheuer. In the interest of time, I am going to forgo any questions. I will suggest that any of the members, including myself, may submit questions in writing to you and we will hold the record open, if there are no objections, for another 10 or 12 days.

I will be happy to yield to my colleague from Wisconsin.

Mr. Sensenbrenner. You mentioned a study is being made on the economic effects of acid precipitation. Very frequently, these kinds of studies are not an accurate indication of exactly what a cause-and-effect relationship would be on why an industry would not want to locate in a given geographic area, so I would hope, in order to make this study useful to yourself as well as to the rest of us who are attempting to find a solution to this problem, that there be some questions asked relative to the impact of other factors such as the level of State taxes and the level of State regulation on these kinds of very critical decisions, as well as the environmental considerations that you really want to get an answer on.

Mr. LANAHAN. I think that is an excellent point, and when we design the questionnaire, we will take that into consideration.

Mr. SENSENBRENNER. I have no further quetions.

Mr. SCHEUER. Congressman Gregg.

Mr. GREGG. Mr. Lanahan, first I want to thank you for appearing today. I believe your office commented on a piece of material I sent to you. Do you have in draft form the proposals you just talked about, with regard to legislative changes?

Mr. LANAHAN. Yes, we do, and I can leave that with the committee today.

Mr. GREGG. Have you reviewed the necessary proposals?

Mr. LANAHAN. Our people have. I am not familiar with it.

Mr. GREGG. You don't know whether yours dovetail with others?

Mr. LANAHAN. Our position was arrived at in conference with the surrounding States. I am sorry I don't know to what extent it would jibe with your State position.

Mr. GREGG. Thank you.

Mr. SCHEUER. Congressman Solomon.

Mr. SOLOMON. The New York State Environmental Conservation Department and I have had ongoing discussions, so I won't take up any time but to say I appreciate Mr. Lanahan's coming here today.

For the committee's record, if you have requests for funds dealing with acid rain—I am talking about your department, not other State agencies—if you would like to give it to us in the record, where you have been denied or the funds have not been forthcoming, it would be interesting for this committee to have it.

I appreciate your remarks about New York State still being a good place to come and fish. In Lake George, we particularly have a real comeback, and we appreciate the department's efforts in that direction.

Mr. SCHEUER. Thank you very much.

Congressman Don Mitchell.

Mr. MITCHELL. Thank you, Mr. Chairman. I have but one question. Was my information correct that at the present level of State funding, it is going to take us nearly 20 years to complete our inventory of the acidity in the various lakes in the Adirondacks? If the State would increase the appropriation to $340,000, we could complete the inventory in 3 or 4 years; is that accurate?

Mr. LANAHAN. That is probably pretty accurate, Congressman. In the legislature this year, in the New York Legislature, there is a proposal for an increase in the fish and wildlife fees which support increased work in this area. We have been working closely with Speaker Fink and Senator Eckhart in the New York State Senate to get that bill passed, and we are very hopeful. That would give us a lot of additional money to put into this problem.

Mr. **Scheuer**. It seems we could quantify our problem. We could give it more specific conventions and people could understand it more readily from other parts of the State.

Mr. **Lanahan**. I agree with you.

Mr. **Mitchell**. Thank you, Mr. Chairman.

Mr. **Martin**. Mr. Lanahan, I want to thank you very much for your testimony. For my colleagues, I just want to make one observation. I can't control the weather in this district any more than I can control a lot of things, but the rainstorm that we endured last night coming over from Plattsburg had a pH level 4.3, which I think speaks for the enormity of the problem.

Mr. **Scheuer**. Commissioner, thank you very much for attending this morning.

I hope, as a New York Member of Congress, chairman of this subcommittee that has jurisdiction over acid rain R. & D. we will be working very closely together and that you will be of help to us as we develop our program. With all due deference to the other 49 States, we want to see New York "primus inter pares," first among equals. We look forward to working closely with you.

Mr. **Lanahan**. Thank you, Mr. Chairman. We look forward to working with all of you and give you the information you need to bring forth our proposals in Congress.

Mr. **Scheuer**. Your testimony will be printed in full at this point in the record, Mr. Bernabo.

STATEMENT OF DR. CHRISTOPHER BERNABO, EXECUTIVE DIRECTOR, U.S. INTERAGENCY TASK FORCE ON ACID PRECIPITATION

Dr. **Bernabo**. Thank you, Mr. Chairman and other members. I will try to be brief. As a native of New York State, and someone who has hiked and canoed in the Adirondacks since childhood, I share a strong concern about this issue. I have a first-hand knowledge of some of the impacts of acid rain.

I am pleased to be here today to describe the recently formed national acid precipitation assessment program. The program was mandated by the Congress in Acid Precipitation Act of 1980, title VII of the Energy Security Act. This legislation set up the Interagency Task Force in Acid Precipitation to pull together all the relevant ongoing Federal efforts and focus them on this very important national issue.

The task force is responsible for developing a comprehensive national program to understand better the causes and effects of acid depositon. The task force is jointly chaired by the Environmental Protection Agency, the National Oceanic and Atmospheric Administration, and the Department of Agriculture. It includes nine other Federal departments, covering all the Federal entities concerned with acid rain, as well as four Presidential appointees and four national laboratories.

The task force functions as an interagency policy board which is responsible for developing a cohesive plan and well-coordinated research program. The research program emphasizes developing a firmer scientific base for decisionmaking in terms of sound environmental and energy policies.

I think it is important to point out, however, that the task force is not responsible for determining what regulatory policies are appropriate. That responsibility, by law, resides with the Environmental Protection Agency.

The legislation calls for a 10-year research program, but I would like to say at the start that doesn't mean we are going to be studying the issue for 10 years before we say anything about it. There will be annual assessments to the President and the Congress of what we do and don't know about acid rain and what the options are.

In planning the national program the interagency task force has taken a number of steps to insure the broadest possible input has been included. The goal is to establish not only a program that links all the Federal efforts but also to coordinate those efforts with the extensive efforts going on in the States, private sector, environmental groups, and other nations, particularly our neighbors in Canada.

In accordance with the act, a draft national plan was sent out for public comment for a period of over 2 months. We sent about 2,000 copies to people and experts all over the country and in other nations, and we have received a wide range of useful comments.

The task force felt that in addition to the public comment period—which is sort of a passive approach to sending out the document and asking for input—we would take other steps to be sure we had the best possible examination of the program we were proposing. We took three such steps. One was to have the joint United States-National Academy of Sciences and Royal Canadian Society Scientific Committee on Acid Deposition review the draft plan. This bilateral group of about 14 scientists sat down and provided very useful comments on the document.

In April 1981, the task force sponsored a workshop which brought together non-Federal individuals with technical expertise relative to acid rain and a wide range of institutional affiliations. We had about 30 participants coming from universities, from various industry groups, environmental groups, and from State governments, including New York.

This group determined that the plan we had proposed was generally speaking a good one. They also gave us a number of excellent suggestions for improving it. There is a report of the workshop and I will provide copies for anyone who would like one.

Third, in June of this year, prior to the beginning of our negotiations with Canada on transboundary air pollution, a delegation of Canadians representing their Federal Government and provincial governments meet with the U.S. task force and discussed the two nations research plans. We encouraged the Canadians to comment on our research plans and we agreed to establish ongoing mechanisms for closely coordinating research between the two countries.

We are seeking to develop joint projects with the Canadians, and we are interested in continuing our mutual cooperation in monitoring the acid deposition occurring in North America.

The task force is working with all this input to produce a final plan to be submitted to Congress sometime soon, I hope early in 1982.

The research program we are undertaking is a comprehensive one. On page 6 of my written statement is a list of the major categories of research. We are looking at everything including manmade sources, possible natural sources of not only acidic material but also alkaline material that neutralizes those acids, atmospheric processes, deposition monitoring, aquatic impacts as well as terrestrial impacts, and effects on materials. We also will be looking at a wide range of control strategies, and we will be providing assessments of what the significance of the scientific data is.

I might point out on the last page of any written statement there is an organizational chart for the task force. It shows the agencies that are involved and along the bottom is a set of task groups. These are working-level groups of experts in these various research areas that are developing the detailed plans necessary to insure that we get the kind of scientific information and focused effort that is necessary.

Let me say something briefly about the strategy of the program. There are five elements we are working on. One of those is that we are going to build upon previous efforts. We are going to take the efforts that have been done before in various agencies and pull them together.

Second, we are going to be using the existing knowledge. There is considerable research that has gone on in Scandinavia, in the United States, Canada, and elsewhere. We will be pulling all that information together in our assessments and using what is available. We will be initiating new research into areas where significant gaps exist in our understanding, particularly focusing on the research most relevant to the decisionmaking process. That is the basic thrust of the program.

Fourth, we are putting strong emphasis on developing a long-term nationwide monitoring network. We are trying to work with all the interested States. For instance, the State of Wisconsin has its own efforts in this area. There are a number of monitoring networks—and we will try to pull those together into a truly national network, where there won't be any argument about the techniques used, and so forth.

Finally, the fifth aspect of our strategy is that we will be continually evaluating information coming out. On a yearly basis we will be making recommendations and assessing the available information. This is not a 10-year study at the end of which all the answers come out. It is an ongoing process.

As far as implementation of the program is concerned, the implementation of the program begins next month with the start of the fiscal year 1982. The President's budget request before Congress includes a 75-percent increase in acid rain research funds over what was spent the year before. That budget was put together by the task force, with all the agencies working together to contribute to a coordinated effort.

One of the unique aspects of the acid rain program is the way the budget process proceeds. The administration makes a decision on how much funds should be allocated to acid rain research and then the various agencies cooperate to establish a research program focused on national needs rather than each agency going off and doing their own missions.

We are confident that this very strong interagency planning process will result in a focused program, one which will get the kind of answers which policymakers in the Congress and the administration need.

In conclusion, I would like to say we are in the final stages of planning the national program. The full implementation will begin next month. We are already looking at the 1983 budget and there is a distinct possibility we will have a request to Congress for further increases in this research area. In these times of tight budgets, that shows a sincere commitment on the part of the administration to go forward with an expanded and accelerated effort to get the answers on acid rain.

I think it is fair to say that we are off to an excellent start. We are trying to work with the full range of interested parties to get their input. We will, on an annual basis, be seeking a council of scientific experts outside of the Government to insure we have the best possible program.

Thank you.

[The prepared statement of Dr. Bernabo follows:]

STATEMENT OF
CHRIS BERNABO
EXECUTIVE DIRECTOR
INTERAGENCY TASK FORCE ON ACID PRECIPITATION
BEFORE THE
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURAL RESEARCH
AND ENVIRONMENT
OF THE
COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES

September 18, 1981
Lake Placid, New York

Mr. Chairman, other Members and guests:

It is a pleasure to be here to describe the status of the recently established U.S. National Acid Precipitation Assessment Program. I am the Executive Director of the Interagency Task Force on Acid Precipitation, which is responsible for administering this national program. I serve in that interagency capacity at the Council on Environmental Quality while on assignment from the National Oceanic and Atmospheric Administration (NOAA) Office of Policy and Planning.

The purpose of the National Acid Precipitation Assessment Program is to identify the sources, causes, and processes involved with acid precipitation, and to evaluate the environmental, social, and economic effects of acid precipitation. My testimony today will include descriptions of the authorizing legislation, the organization of the Federal acid rain research effort, the planning process, the program's strategy, and the implementation of the National Program.

Legislation and Organization

The Acid Precipitation Act of 1980 (Title VII of the Energy Security Act of 1980 - P.L. 96-294) establishes the Interagency Task Force on Acid Precipitation. The Task Force is charged with planning and implementing a comprehensive research program to understand better the causes and effects of acid precipitation. The legislation mandates the production of a ten-year plan to outline a National Acid Precipitation Assessment Program.

The Task Force is jointly chaired by the Department of Agriculture (DOA), the Environmental Protection Agency (EPA), and the National Oceanic and Atmospheric Administration (NOAA). It includes the nine other Federal entities concerned with acid precipitation research, including: the Council on Environmental Quality (CEQ); the Departments of Commerce (DOC), Energy (DOE), the Interior (DOI), State (DOS), Health and Human Services (DHHS); the National Aeronautics and Space Administration (NASA); the National Science Foundation (NSF); and the Tennessee Valley Authority (TVA). The Task Force also includes four Presidential appointees and the Directors of the Argonne, Brookhaven, Oak Ridge, and Pacific Northwest National Laboratories. An organizational chart of the Task Force is shown on page 11.

The Task Force functions as an interagency policy board to develop and oversee a cohesive and well-coordinated research program. The research efforts are focused on obtaining a firmer scientific basis for the establishment of sound environmental and energy policies. The Task Force is not, however, responsible for determining or promulgating regulatory policies. By law, that responsibility rests with the Environmental Protection Agency which is charged with the Federal regulation of pollution sources.

Although the Act calls for a ten-year program, the Task Force will issue annual reports to the President and Congress. These annual reports will outline: research progress, the current status of our knowledge about acid precipitation, and the possible policy options for addressing problems associated with acid precipitation. The initial report will be available in late-1982, after the first year of the research program's implementation. The Task Force is committed to conducting a vigorous policy-oriented research program that will provide timely input to policymakers.

The primary responsibilities of the Task Force are to:

- Develop and update the National Acid Precipitation Assessment Plan;
- Oversee and implement a comprehensive ten-year research program that coordinates and focuses the activities of the Federal agencies;
- Provide annual reports on the program's progress and policy implications;
- Encourage productive interaction between Federal efforts and private sector, academic, state and local governmental and international activities;
- Maintain an inventory of Federally-funded acid precipitation research projects;
- Produce an annual interagency budget for the Federal program;
- Obtain non-Federal input to the planning and program activities.

The individual agencies will manage and operate their own projects but now these efforts will be carried out in the context of the National Program as defined by the current ten-year plan and with oversight by the Task Force.

One source of confusion about the Acid Precipitation Act of 1980 and its implementation is the authorization it contains. The Act authorizes $5 million per year to NOAA in addition to the regular authorizations for acid rain research for all participating agencies. Prior to the Act, the various Federal agencies were conducting acid rain research amounting to approximately $12 million in fiscal year 1980. The new authorization to NOAA was meant to enhance the total program effort and provide resources for coordination and gap-filling activities. The Act designated the Administrator of NOAA as the Director of Research to oversee the program and called for the formation of a "research management consortium" composed of the four National Laboratories.

Neither the Carter or the Reagan Administration requested funds under this particular authorization, nor did Congress choose to appropriate such funds. The President's FY 1982 budget requests an increase in acid rain research funding of $8 million over 1981 expenditures. However, rather than channeling these funds to one agency to be "passed through" to other agencies, it was decided to seek increased appropriations directly to the agencies actually performing the work. This will result in a greater increase in total program funding than envisioned under the Act, complemented by more efficient distribution.

Planning Process

In developing the National Program the Interagency Task Force on Acid Precipitation sought input from a broad spectrum of concerned groups. The Task Force's goal is to establish a program that not only links all Federal efforts, but also effectively coordinates those efforts with the substantial research and monitoring activities of the states, private sector groups, and other nations — particularly our neighbors in Canada.

In accordance with the Act (PL 96-294), a draft National Acid Precipitation Assessment Plan was submitted to Congress in January, 1981. Two thousand copies were distributed during and after the mandated sixty-day public comment period. Comments were received from state and local governments, universities, environmental groups, various industries, the general public, and other nations. The many valuable suggestions of these groups are being given careful consideration as we revise and improve the draft National Plan.

In addition to the input from the public comment period, the Task Force has taken other steps to ensure adequate review of the draft National Plan. A joint U. S. National Academy of Sciences and Royal Society of Canada Scientific Committee on Acid Precipitation reviewed the draft plan in March, 1981. This bilateral group of 14 prominent scientists provided the Task Force with a very useful critique of the draft document.

In April of 1981, the Task Force sponsored a workshop of non-Federal experts to critically review the plan and provide suggestions on how the Federal efforts could best be coordinated with the state and private sector activities. The workshop involved a balanced group of 27 participants with diverse expertise and affiliations including state governments, environmental groups, and various industries. They determined the draft was, in general, an excellent beginning and they suggested many extremely valuable improvements.

Last month (June, 1981), a delegation of Canadians representing the various Federal and Provincial research groups met with the Task Force representatives to discuss our draft plan. We exchanged information on the two nations' acid rain research efforts and agreed to establish ongoing mechanisms for coordinating research, developing joint projects, and continuing and expanding collaboration in monitoring activities.

The Task Force is now working with the input from these diverse sources as it revises the draft plan. A final version of the National Acid Precipitation Assessment Plan should be completed by early fall. Improvements to the draft Plan will include strengthening the section on international cooperation, providing greater attention to the role of state and private sector efforts in the National Program, and fine tuning the proposed research. The linkages between research on aquatic and terrestrial ecosystems will be reinforced and more emphasis will be placed on studying the effects of acid rain on materials. Also, the discussion of control strategies will be expanded. Through the Task Force's intensive efforts to make these and other improvements, we are confident the final plan will be an excellent blueprint for a sound National Acid Precipitation Assessment Program. The program's annual reports will provide a mechanism for periodically updating and refining the National Plan.

Proposed Research

The National Acid Precipitation Assessment Program includes a comprehensive set of research projects to provide urgently needed information, on the phenomena and consequences of acid rain. Assessment will be made of the envirommental and policy implications of this information, and potential strategies for effectively dealing with acid precipitation and its effects will be evaluated.

The draft National Plan includes projects in nine research categories. The reseach categories and the "lead" agencies responsible for them are:

Category	Lead Agency	Category	Lead Agency
A. Natural Sources	NOAA	F. Terrestrial Impacts	DOA
B. Man-made Sources	DOE	G. Effects on Materials	DOI
C. Atmospheric Processes	NOAA	H. Control Strategies	EPA
D. Deposition Monitoring	DOI	I. Assessment and Analysis	EPA
E. Aquatic Impacts	EPA		

The Plan identifies information needs in each category and defines the research tasks required to provide that information. The relative priority of the research tasks, their duration, and the agencies involved are also indicated in the Plan.

The lead agencies will not be the sole performers of research in their assigned categories. A number of agencies will be participating in or contributing to each of the research categories, with the lead agencies responsible for coordinating and overseeing these efforts for the Task Force.

Interagency task groups have been formed for each category and are chaired by the appropriate lead agencies. These working-level groups report to the full Task Force and are responsible for detailed planning and implementation of the program outlined in the National Plan.

The Task Force also will establish an international task group, chaired by the Department of State. This group will ensure that the U. S. National Program is supportive of and coordinated with relevant international activities.

Program Strategy

The National Acid Precipitation Assessment Program will use a general strategy that includes:

- Building upon previous efforts to develop a Federal acid rain program. The former Acid Rain Coordinating Committee (ARCC) has been reconstituted to form the statuatory Task Force and the ARCC draft plan served as a foundation in developing the current plan.
- Using existing scientific knowledge for developing timely assessments and evaluating possible policy options. Currently available data and information from the U. S. and other nations will be analyzed and applied to the maximum extent possible.
- Initiating new research to acquire more knowledge. The emphasis in the proposed research is on activities that contribute most effectively to establishing a firmer scientific basis for decisionmaking.

- Establishing a long-term National Trends Network (NTN). The development and maintenance of a well-designed acid deposition (wet and dry) monitoring network is essential for documenting and understanding acid precipitation and its effects. Exisiting monitoring efforts, such as those of the National Atmospheric Deposition Program (NADP), will be incorporated into the NTN.
- Continuously evaluating information on acid precipitation and its effects. Information generated by this program and elsewhere will be periodically analyzed and interpreted to guide decisions on future research and policy.

The National Program will utilize the expertise avaliable in Federal and state agencies, universities, industry, private contractors, research institutions and other nations.

Implementation

Full implementation of the National Acid Precipitation Assessment Program will begin in October, 1981 (the start of the fiscal year 1982). The Task Force prepared the acid rain research budget contained in the President's FY 1982 budget request now before Congress. The President's FY 1982 budget calls for an acid rain research effort of about $20 million. This is approximately a 75 percent increase in the $12 million being spent on acid rain activities in FY 1981. These figures include only research directly related to acid precipitation, while about three times that amount is being committed to research that indirectly contributes to the "core" National Program.

The role of the Task Force in planning the interagency budget for the National Program is a unique and highly effective aspect of the Federal effort. By working together through the Task Force, the agencies are establishing a research program that focuses on addressing national needs, rather than having each agency independently pursuing its own mission. The strong interagency planning process avoids proliferation of a set of loosely related projects and thus eliminates wasteful duplication.

After the Office of Management and Budget (OMB) determines the annual funding level for the National Acid Precipitation Assessment Program, the Task Force sets the research goals, identifies the projects needed to meet those goals, and decides which agencies are best suited to conduct the necessary work. The result is a tight, well-designed program of interlocking projects, with each agency contributing to specific aspects of the overall national effort. OMB's very constructive role in reviewing the various agencies' budget requests as part of a single interagency package is crucial to the success of this process.

Concluding Remarks

The Task Force is in the final stages of planning the National Acid Precipitation Assessment Program and will be fully implementing the vigorous research effort this Fall. The President's FY 1982 budget calls for an accelerated and expanded acid rain research program of $20 million, compared to the $12 million spent in FY 1981. The intensive research in the initial years of this program will produce a firmer scientific basis for policy decisions. We look forward to Congress acting favorably on this total budget request, portions of which are contained in each of the participating agencies appropriations bills.

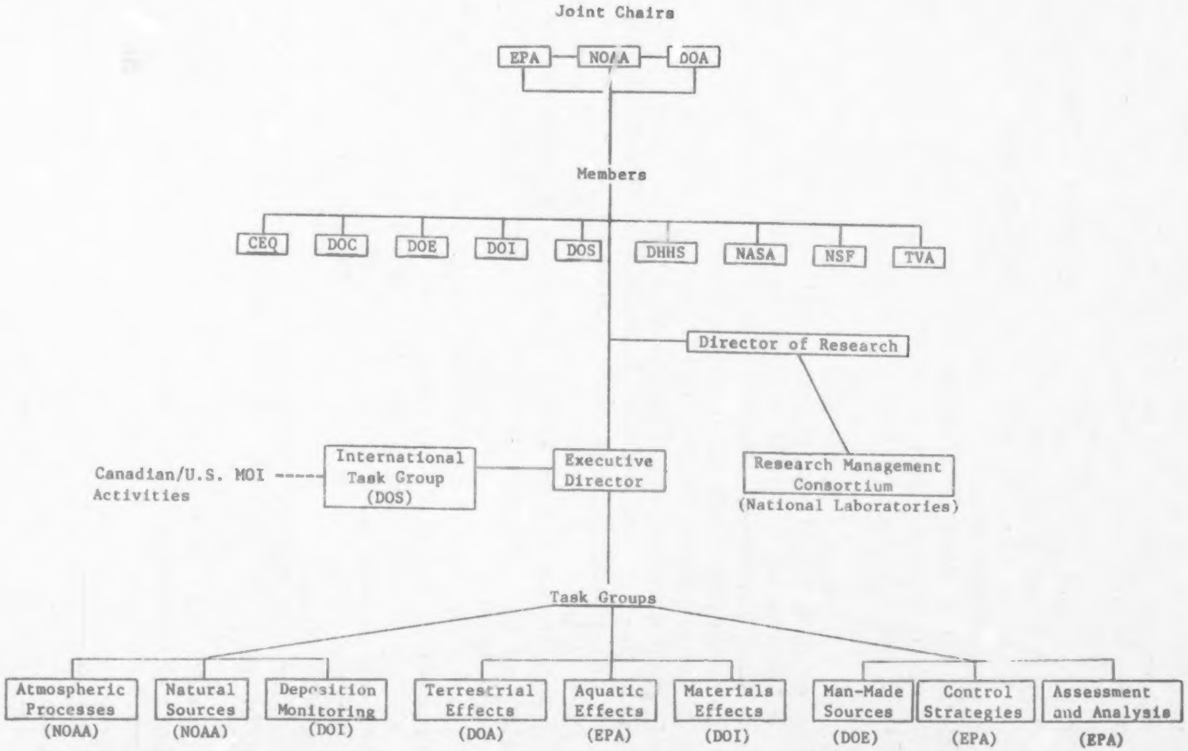
The Task Force is off to an excellent start with all of the agencies working together to build a well-coordinated and comprehensive National Program. The draft National Plan was extensively reviewed and the Task Force actively sought input from a wide range of technical experts and concerned groups in developing the program. The Task Force will continue to work closely with all interested parties - the states, environmental organizations, industry, academia, and other nations - to conduct a national program addressing the urgent issues associated with acid rain.

Thank you, Mr. Chairman, for the opportunity to appear before you today. This completes my statement. I would be happy to answer any questions the Subcommittee has on the Task Force or the U.S. National Acid Precipitation Assessment Program.

Appendix A

INTERAGENCY TASK FORCE ON ACID PRECIPITATION

Organizational Chart


Joint Chairs
EPA
NOAA
DOA
Members
CEQ
DOC
DOE
DOI
DOS
DHHS
NASA
NSF
TVA
Director of Research
Canadian/U.S. MOI Activities
International Task Group (DOS)
Executive Director
Research Management Consortium (National Laboratories)
Task Groups
Atmospheric Processes (NOAA)
Natural Sources (NOAA)
Deposition Monitoring (DOI)
Terrestrial Effects (DOA)
Aquatic Effects (EPA)
Materials Effects (DOI)
Man-Made Sources (DOE)
Control Strategies (EPA)
Assessment and Analysis (EPA)

Mr. **Scheuer**. Thank you for your excellent testimony, Dr. Bernabo. We look forward to receiving your counsel and suggestions on legislation that would be appropriate for this subcommittee, and also the Health Subcommittee, when we come to writing amendments to the Clean Air Act.

Because we have limited time here. I will call upon Congressman Carney first for questions.

Mr. **Carney**. Doctor, one of the problems that we have with acid rain is that the data base that we utilize to try to determine the effects of acid rain is continually under attack.

I don't think you have to go too far, particularly if you are up in Lake Placid, to have an understanding of the devastation of acid rain.

Would it be fair to say that the scientific community has sufficient evidence that would identify the effects of acid rain?

Dr. **Bernabo**. I would say in the case of aquatic impacts it is clear that the acidification of lakes is occurring. There are other areas however, such as possible impacts on crops, health and so forth, where the evidence is far less straightforward. In fact, you have distinguished scientists disagreeing on some of the basic facts. But in the area of aquatic impacts the consensus is pretty clear. Here in the Adirondacks, that is currently the prime concern.

From a national standpoint there is a far wider range of potential impacts we should be concerned about when assessing the total extent of the problem and how much we might be willing to pay for a solution.

I think there will be other witnesses following me who might address the specifics of this better, but there are major uncertainties.

Mr. **Carney**. Is the scientific community in agreement that the methods we use to measure the acidity is adequate?

Dr. **Bernabo**. Since 1978, thanks to the efforts of Dr. Ellis Cowling and others, we have a growing network of sites to uniformly monitor atmospheric deposition and provide a good data base. The problem is that we only adequately measure what falls out in rainfall. It turns out that much of the acidic material in the atmosphere comes as dry deposition, and we haven't devised yet a method to measure that adequately. Perhaps half of the problem therefore is not yet even reliably measurable, and that is something we are working on intensively.

Mr. **Carney**. And one we have the biggest problem with is having a way of determining the point source of the pollution.

Dr. **Bernabo**. That is correct.

Mr. **Carney**. I look at it as having, when we try to identify the source, and when we try to measure the amount, and we try to analyze its impacts, in all three areas we have an awful lot of work to do. The scientific community has an awful lot of work to do to enhance our knowledge in all three areas.

Dr. **Bernabo**. That is a fair statement.

Mr. **Carney**. With all your knowledge, having worked with many of these agencies, could you give us an idea as to the timeframe when we could have a data base for efficiency in those three areas? I know it is a dynamic thing, and we will improve with more research. We will never have enough information, but when will we have a data base efficient enough to actually identify the source of pollution, where we can take some sort of corrective action and perhaps not have our action turned back in court, or whatever?

We should have a data base sufficient for us to react and correct the problem. What timeframe would you have?

Mr. **Bernabo**. I can't give you a definite date, as you know. Our knowledge is not something that progresses in a way that one might predict with certainty.

However, I think it is fair to say, given that we now have a focused national program with increased resources that even in the first 2 years of the program a number of major uncertainties will narrow. In the atmospheric area in particular our understanding should rapidly expand.

In other areas, like the long-term impacts on ecosystems, it may take many years before we have more definitive answers. We can move foward, but of course, we will never have full knowledge of all aspects of the problem. At some point along the line, decisionmakers in the Congress and the executive branch, will have to decide that there is enough information to act on.

Mr. **Carney**. Mr. Chairman, I could ask the good doctor several more questions, but I will yield to my colleagues in deference to the time problem.

Mr. **Scheuer**. We have 2 more minutes with Dr. Bernabo.

Do any of my colleagues have questions for him?

Mr. **Gregg**. I take it you disagree with Mr. Lanahan, who feels—and a great many people in the environmental field, especially representatives of the clean air coalitions and Sierra Club, the Audubon Society—you feel we now have enough information to move in the immediate regulatory activity and corrective activity?

Dr. **Bernabo**. Let me say our efforts to determine this are just beginning. Each year, we will be giving a report on what the study of our knowledge is. We have yet done that. We are just pulling it together.

I have something that just came out the other day from the General Accounting Office on this issue, which is an excellent review. There is a lot of rhetoric. This is a very polarized issue, as you know. We have people on both sides of the issue who are doing more to make a case than to look at the facts.

I was surprised at how balanced this document is. It is called "A Debate Over Acid Precipitation, Opposing Views." It just came out this week from the General Accounting Office, and I got a copy yesterday.

In a valuable way the report lays out what is being said on both sides of the issue, and it shows where consensus exists. When you look at that, you will note it also points out a lot of misinformation is floating around on both sides of the issue. It is a very valuable document to put into perspective what we know and don't know, and the area of consensus. There is a surprising amount of consensus that gets lost in the rhetoric. I think that is an important point.

Mr. **Mitchell**. As everyone here knows, one excellent way to postpone the solution to a problem is study it, and study it, and study it.

I am hopeful that further studies by this task force are not going to just postpone some action. I can see how we can't have views from the task force, but you as a scientist, may we ask your personal view. Do you think we have enough data assimilated to at least want to attack the problem of pollution from the Ohio Valley? Can you make a cause-and-effect relationship there, enough to warrant some expenditure of funds and some regulatory action?

Dr. **Bernabo.** I suppose, unfortunately, I am familiar enough with the data to know I could not come to you, and I would be very suspicious of anyone who comes to you and says, "I have a solution to this problem. I know if you reduce emissions this amount, you will get this result."

No one can do this yet. Right now, we'd be pulling that number out of a hat. If you are comfortable with that as a decisionmaker, fine.

We have hanging in the balance potentially billions of dollars in capital investment for control measures as well as billions of dollars to maintain that.

On the other hand, we have hanging in the balance potentially billions of dollars in impacts on resources, so more research seems very prudent.

Mr. **Mitchell.** We hang in the balance, too, the death of a lot of lakes in the Adirondacks. I think they have been studying the problem in Europe so much that Sweden has lost all its lakes.

Dr. **Bernabo.** As I say, we have billions of dollars of potentially at stake based on a decision to regulate or not to regulate. If I were a decisionmaker, I would want to be in a position to have the best possible information. I would want to know what the costs and benefits would be—even in the most general sense. Action for action sake, if it isn't going to provide a real solution, could be a mistake that slows us from eventually taking the most effective cure.

Mr. **Mitchell.** I have been in hearings where we had two Ph. D's who taught in the field for years, with good credentials, take diametrically different views on this. I hope we can get some definitive answers from your task force promptly, because time is running out. Sweden has lost all of her lakes, and we are rapidly approaching that situation in New York State. We can't afford to wait.

Dr. **Bernabo.** We are moving foward with urgency—we have a 75-percent increase in next years budget. We will be reassessing our efforts on a yearly basis. The urgency is well understood by the administration and obviously by the Congress. I think the charge that we are just doing research to hold off action is not a fair one in the following sense: If you had a situation where the basic facts were agreed to, and we were just getting that next decimal point or arguing about details, then that would be a fair accusation; but we have a situation where distinguished scientists don't even agree on some of the basic facts. I think——

Mr. **Scheuer.** If I can interrupt the doctor, that is the way we postpone things. I have heard distinguished scientists take opposite views.

Dr. **Bernabo.** You have to separate fact from opinions, how the facts are interpreted. Scientists, like legislators, are entitled to their opinions as to the significance of the available data.

Determining how much information is enough is not a scientific question; it involves a value judgment. The scientist can make that judgment, or a legislator, but you have to be careful where the facts leave off and where interpretation of facts begins. That is often what you are talking about—interpretation. We don't even have some of the basic facts agreed to.

Mr. **Scheuer**. I hope you impress upon your interagency participants the urgency of the problem, because we can nitpick this thing for 15 more years and end up with nothing.

Dr. **Bernabo**. We are not in the nitpicking phase; we are in the phase of defining basic aspects of the problem.

Mr. **Mitchell**. I thank you, Doctor.

Mr. **Martin**. Just one comment.

I wanted to make the doctor aware of one thing that was given to me yesterday by Congressman Bill Hendon, of North Carolina, another of our colleagues who wanted to be here but could not because of a conflict.

It is an article out of the Chattanooga, Tenn. Times, relating to the Tennessee Valley Authority and the burning of coal and the impact it is having allegedly on the Cherokee Indian Reservation there in North Carolina.

Are you aware of that specific flare-up?

Dr. **Bernabo**. Not at all.

Mr. **Martin**. I will be sure that you have that. Your interagency task force would be interested because it is a classic example of being able to show the cause-and-effect relationship.

Dr. **Bernabo**. If I may make one more comment, we are here discussing the Adirondacks and the issue in general. I think it is important to point out this is increasingly a nationwide issue. There are now acid rain task forces in the States of Texas, Florida, and elsewhere.

Mr. **Scheuer**. How many States do have legislative or executive branch initiatives in the field of acid rain?

Dr. **Bernabo**. To my knowledge, the most advanced one is in the State of Wisconsin, where I think they are spending over $1 million a year on this. It is jointly funded by the utility industry and the State.

Mr. **Scheuer**. How many other States?

Dr. **Bernabo**. California is now considering it, and I think it has a good chance of going forward. Texas has a major task force.

Florida also has a task force because they are considering a major conversion to coal. There are obvious efforts in New York State. It is a handful, but it is growing, and rapidly.

Mr. **Scheuer**. Is there liaison between them, any joint coordination?

Dr. **Bernabo**. That has been one of our problems. We have tried very hard to find out how to get them to effectively relate to us. In the State of Wisconsin we have some good communication on their monitoring but to date there is no good focus on a national basis.

In the National Governors Association, Governor Lamm and others have been very interested but its a regionally devisive issue. Colorado feels their synfuels development might have impact on their environment, and the concerns are warranted. There is a growing movement, but there is no good focus.

Mr. **Scheuer**. You have heard from Congressman Sensenbrenner, so you have some idea of the excellent quality of leadership that the State of Wisconsin is providing.

You have heard from Speaker Fink. There really is a lot of initiative and a lot of expertise, a lot of excellence in the States, both in the Governors, in the executive branch, as well as the legislatures. It is a shame that is not all being tapped and a focal point being provided.

Dr. **Bernabo**. Absolutely, because the problem of acid rain in California is very distinct. There is a need for the people in the region to deal with.

Mr. **Mitchell**. Just one fast question of the good Doctor You mention your funding will be increased by 75 percent this year, but you didn't say 75 percent of what. Do you have adequate funding? Can we get the answer faster if you have more money, or will it take a long time regardless of the number of dollars you have to work with?

Dr. **Bernabo**. Like anyone else, scientists would always like more, but I think since the program is experiencing healthy growth—it is about $12 million in 1981 and we are moving to $18 million in 1982. That is a fairly large growth rate for us to absorb and still be sure it is well directed. I personally think we could use more, but we need a phasing in of the increased resources. If you suddenly double the program, we might not have a well-managed program.

Mr. **Mitchell**. Thank you.

Mr. **Scheuer**. Are there further questions?

Thank you very much.

We are impressed with the number of people in the audience, particularly young people. When our afternoon session is finished, at approximately 4 o'clock, we will stay around for another half hour or so and answer any questions from the audience. If any of you want to stick it to the Members of Congress, you will have your chance for a little while.

STATEMENTS OF JAY JACOBSON, BOYCE THOMPSON INSTITUTE, CORNELL UNIVERSITY, ITHACA, N.Y. VOLKER A. MOHNEN, DIRECTOR, ATMOSPHERIC SCIENCE RESEARCH CENTER, STATE UNIVERSITY OF NEW YORK AT ALBANY; DUDLEY RAYNAL, ASSOCIATE PROFESSOR, DEPARTMENT OF ENVIRONMENTAL AND FOREST BIOLOGY, SCHOOL OF BIOLOGY, CHEMISTRY AND ECOLOGY, STATE UNIVERSITY OF NEW YORK AT SYRACUSE; AND ROBERT SINGER, PROFESSOR, BIOLOGY DEPARTMENT, COLGATE UNIVERSITY

Dr. **Jacobson**. Thank you, Mr. Chairman, and members of the subcommittee. I appreciate this opportunity to give you some of my ideas on certain aspects of the problem of acid rain.

My written testimony consists of two parts. For purposes of brevity, I will only go into the first part, considering the effects of acid rain on agriculture, though I will be happy to consider questions on either part.

There are several facts about the deposition of pollutants from the atmosphere that are undeniable. One of these facts is that acidity, mainly in the form of sulfuric and nitric acid, is present in almost every rain and snow event in the eastern United States, including all of New York State. It is deposited on farmland, forests, lakes and buildings. The possibility that acid deposition may have adverse effects on agriculture is, therefore, one important consideration.

More than 50 percent of the land in New York State is wooded and over 25 percent is classified as farmland. A majority of the cropland is in hay and field corn, and the most valuable crops in this State are hay, field corn, and apples. However, New York State also supplies a large share of the country's supply of cabbage, sweet corn, apples, sour cherries, grapes, dairy products, and onions.

The first question that I will attempt to answer is, does acid rain damage crops and trees?

Currently available evidence from experimental studies indicates that some crops may be damaged while other crops may undergo increases in yields from exposure to acid rain. Research in a number of laboratories do not provide support for the all-inclusive proposition that acid rain damages crops and trees.

The actual situation is complex. Acid rain occurring at one stage of plant development may have a different effect than when it occurs at another stage of plant maturity. Plant species, varieties, soil conditions, cultivation practices, and weather conditions all may affect how plants respond to current levels of contaminants in rain.

Research needed. Initially, quick and simple experiments were performed. Tests with greenhouse-grown plants are less expensive than tests with field-grown plants, but, unfortunately, greenhouse-grown plants respond differently than plants grown in the field. Experiments utilizing foliar symptoms as the criterion of effects of acid rain can be performed more quickly than tests that measure reductions in yield. Unfortunately, foliar symptoms can occur more or less readily than yield reductions. Only a few experiments are required if results with one species are representative of many plant species. However, there are significant differences in the way different species respond.

Similarly, results obtained under one particular set of soil and climatic conditions are not necessarily valid for other conditions. So, research must be performed in the field using different crops over periods of several growing seasons at a number of different sites if we want to have accurate and reliable information on which to base policy decisions.

A second question: Does acid rain provide important nutrients that benefit crops and trees?

The answer is yes, acid rain does provide important nutrients and, under some conditions, these nutrients increase plant productivity. Nitrogen and sulfur are constituents of rain and essential elements in plant metabolism. When growth is limited by the supply of these elements, additions from the atmosphere are beneficial. For example, in a series of tests at the Corvallis Environmental Research Laboratory of the U.S. Environmental Protection Agency, 28 crops were exposed to simulated acid rain. Yield was reduced for five crops, increased for six crops, and not affected in a consistent way for the remainder.

These tests and those performed at other laboratories suggest that there are two opposing processes involved in the effects of acid rain on vegetation. When acidity is sufficiently high, the detrimental effects can take precedence over the beneficial ones. When concentrations of acidity in simulated rain are higher than those occurring now, reductions in productivity are more likely.

Research needed. Initial results require verification in order to make conclusive interpretations. Research is proceeding at several laboratories, including two in New York State, the Brookhaven National Laboratory and the Boyce Thompson Institute, to determine the quantitative relationships between acidity, sulfate, and nitrate concentrations and plant growth and productivity.

Is acid rain the only source of acidity in terrestrial ecosystems?

No, it isn't. Natural processes in humid areas of the country, such as New York State, lead to the formation of acids. Biochemical processes in plants and in soil microorganisms produce greater quantities of acidic substances than the amounts deposited from the atmosphere. Furthermore, the addition of fertilizer to cultivated soils has an acidifying effect that is greater than that caused by the deposition of acid from the atmosphere.

Does this mean—the fact there are naturally acidifying processes—does this mean the acidity of rain makes a trivial contribution that can safely be ignored?

No, not necessarily. It appears as though the importance of acid rain depends on the system under observation and the particular location.

So the answer may be that acid rain makes an important contribution in some systems and locations and a relatively unimportant contribution in others.

Clearly we need more research to determine exactly where, when, and to what degree acid rain is important to the functioning of terrestrial ecosystems.

There are several other questions in my written testimony that are available for you to read.

Let me move to the end of my testimony.

If clear, unequivocal answers to questions about the effects of acid rain on terrestrial vegetation are not available, then what reliable information is of value for policy decisions?

Some general statements can be made without equivocation. If rain were less acid than it is now, for example, if the pH values of individual rain events were 4.5 to 6 instead of approximately 3 to 5.5, as they are now, there would be essentially no concern over possible effects on crops and trees. On the other hand, if rain were to become more acid than it is now, then the risk of injury to vegetation will increase.

There is also a broader lesson in the acid rain problem. For decades we have added large quantities of pollutants to the atmosphere. We now know that alterations have occurred in important global processes that involve the transport of substances, the chemical and physical transformation of these substances and their deposition from the atmosphere. We expect to learn enough in the space of a few years to answer questions that appear simple, but in reality are very complex.

How will the composition of rain change if emissions are reduced? What improvements in environmental quality will result? How much more acid will rain be if emissions are allowed to increase? How much of an increase in deposition of acids can be tolerated before major decreases occur in agricultural productivity? It takes only minutes for the pollutants of a nation to alter vast natural processes, but understanding of the consequences is gained slowly and only by persistent effort.

Thank you very much.

[The prepared statement of Dr. Jacobson follows:]

TESTIMONY OF DR. JAY S. JACOBSON

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Before the

Subcommittee on Natural Resources, Agriculture Research, and Environment of the House Committee on Science and Technology

Lake Placid, New York

September 18, 1981

Introduction

More than 50% of the land in New York State is woodland and over 25% is classified as farmland. Most of the cropland is in hay and field corn but the most valuable crops are hay, field corn, and apples. New York State supplies a large share of the U.S. supplies of cabbage, sweet corn, apples, sour cherries, grapes, dairy products, and onions.

The total market value of crops in New York State is approximately 0.5 million dollars and several large industries are dependent on agricultural production. All of New York State, as other states in the northeastern U.S., receives deposits of dilute solutions of sulfuric and nitric acid practically every time it rains or snows. Therefore, the possible effect on agriculture of acid rain and other pollutants in New York State is an important question to consider.

Question 1.

Does acid rain damage crops and trees?

Answer

Currently available evidence indicates that some crops may be damaged while other crops may undergo increases in yield from exposure to acid rain. Research performed in a number of laboratories throughout the country does not provide support for the all-inclusive proposition that acid rain damages crops and trees. The actual situation is complex. Acid rain occurring at one stage of plant development may have a different effect when it occurs at another stage of plant maturity. Species of plant, variety, soil conditions, cultivation practices, and weather conditions all may affect how plants respond to current levels of constituents in acid rain.

Research Needed

Initially, quick and simple experiments were performed. Tests with greenhouse-grown plants are less expensive than tests with field-grown plants but, unfortunately, greenhouse-grown plants respond differently than plants grown in the field. Experiments utilizing foliar symptoms as the criterion of effects can be performed more quickly than tests that measure reductions in yield. Unfortunately, foliar symptoms can occur more or less readily than yield reductions. Only a few experiments are required if results with one species are representative of many plant species. However, there are significant differences in the way different species respond. Similarly, results obtained under one particular set of soil and climatic conditions are not necessarily valid for other conditions. So, research must be performed in the field using different crops over periods of several growing seasons at a number of different sites if we want to have accurate and reliable information on which to base policy decisions.

Question 2.

Does acid rain provide important nutrients that benefit crops and trees?

Answer

Yes, acid rain does provide important nutrients and, under some conditions, these nutrients increase plant productivity. Nitrogen and sulfur are constituents of rain and essential elements in plant metabolism. When growth is limited by the supply of these elements, additions from the atmosphere are beneficial. For example, in a series of tests at the Corvallis Environmental Research Laboratory of the U. S. Environmental Protection Agency, 28 crops were exposed to simulated acid rain. Yield was reduced for 5 crops, increased for 6 crops, and not affected in a consistent way for the remainder. These tests and those performed at other laboratories suggest that there are two opposing processes involved in the effects of acid rain on vegetation. When acidity is sufficiently high, the detrimental effects can take precedence over the beneficial ones. When concentrations of acidity in simulated rain are higher than those occurring now, reductions in productivity are more likely.

Research Needed

Initial results require verification in order to make conclusive interpretations. Research is proceeding at several laboratories including two in New York State, the Brookhaven National Laboratory and the Boyce Thompson Institute, to determine the quantitative relationships between acidity, sulfate, and nitrate concentrations and plant growth and productivity. One of the experimental difficulties is that the occurrence and composition of rain is variable. Although acid rain occurs throughout the eastern North America, the chemical composition varies with season, with events, and within events. Experiments have been performed using constant concentrations of components of rain but extrapolation of these results to the field situation is uncertain. Improvements in experimental methods and approaches is needed in order to verify and provide a more reliable basis for conclusions.

Question 3

Does damage to vegetation occur when acid rain contacts leaves and flowers or by the leaching of nutrients from soil producing a reduction in soil fertility?

Answer

Short-term effects, such as those occurring within a growing season, probably are produced by contact of acid rain with leaves and/or flowers. Long-term, cumulative effects on plant productivity, if they occur, are the result of decreases in soil fertility. On the generally less fertile soils of mountainous and forested areas of New York State, soil scientists believe that fertility might decrease within decades. On fertile soils that have lime and fertilizer added, we may never be able to detect changes in fertility caused by acid rain.

Question 4

Is acid rain the only source of acidity in terrestrial ecosystems?

Answer

No, it isn't. Natural processes in humid areas of the country such as New York State, lead to the formation of acids. Biochemical processes in plants and in soil microorganisms produce greater quantities of acidic substances than the amounts deposited from the atmosphere. Furthermore, the addition of fertilizer to cultivated soils has an acidifying effect that is greater than that caused by the deposition of acid from the atmosphere.

Research Needed

It is important to quantify the relative impacts of acidity from the different natural and artificial sources and research on this subject should be pursued.

Question 5

Does the occurrence of natural acidifying processes mean that the acidity of rain makes a trivial contribution that can safely be ignored?

Answer

No, not necessarily. It appears as though the importance of acid rain depends on the system under observation and the particular location. So the answer may be that acid rain makes an important contribution in some systems and locations and a relatively unimportant contribution in others.

Research Needed

Much more information is required to determine exactly where, when, and to what degree acid rain is important to the functioning of terrestrial ecosystems.

Question 6

There is a considerable amount of pastureland and marginal farmland in New York State that already is relatively acidic and does not have regular additions of lime and fertilizer. Is productivity of these farmlands endangered by acid rain?

Answer

We don't know but there is concern over the possibility that pasture and marginal farmlands may be more readily influenced by acid rain than other agricultural lands.

Research Needed

To my knowledge, no state or federal funds are being used for research on this question. Research should be initiated and performed within New York State on this subject.

Questions 7.

Are there other special concerns over the impact of acid rain on vegetation?

Answer

Yes, there are. One concern involves the air pollutant, ozone, that also is produced by atmospheric reactions involving emissions from the combustion of fossil fuels and is transported long distances. Ozone is known to cause more damage to vegetation than any other pollutant in the U.S. Initial investigations, performed at the Boyce Thompson Institute, suggest that, when ozone concentrations are high enough to cause plant injury, exposure to acid rain may enhance the harmful effects.

Research Needed

These initial results require verification through additional research. But there is a serious difficulty in designing experiments on the subject.. We know that elevated concentrations of ozone occur in New

York State during the growing season and that areas in the southeastern part (Long Island, New York City, and the Hudson Valley) and in the western part of the state (Buffalo-Niagara Falls and east to Syracuse) probably are exposed to the highest concentrations of ozone. But there is no data available on the actual concentrations that occur in farming areas where ozone-susceptible crops are grown. So we don't know how much ozone to expose crops to in our experiments. A few monitoring sites in agricultural locations of the state would be sufficient to obtain this data.

Question 8

If clear, unequivocal answers to questions about the effects of acid rain on terrestrial vegetation are not available, then what reliable information is of value for policy decisions?

Answer

Some general statements can be made without equivocation. If rain were less acid, for example if the pH values of individual rain events were 4.5 to 6 instead of approximately 3 to 5.5 as they now are in New York State, there would be essentially no concern over possible effects on crops and trees. If rain were to become more acid, then the risk of injury to vegetation will increase.

There also is a broader lesson in the acid rain problem. For decades, we have added large quantities of pollutants to the atmosphere. We now know that alterations have occurred in important global processes that involve the transport of substances in the atmosphere, the chemical and physical transformations of these substances, and the deposition of materials from the atmosphere. We, apparently, expect to learn enough, in the space of a few years, to answer questions that appear simple but are, in reality, very complex. How will the composition of rain change if emissions are reduced? What improvements in environmental quality will result? How much more acid will rain be if emissions are allowed to increase? How much of an increase in deposition of acids can be tolerated before major decreases occur in agricultural productivity?

It takes only minutes for the pollutants of a nation to alter vast natural processes but understanding of the consequences is gained slowly and only by persistent effort.

Mr. SCHEUER. Thank you for your very excellent testimony, Dr. Jacobson.

You told us a few minutes ago fertilizer added more to acidity than acid rain. It seems in your view fertilizer is a major contributor to acidity and, in fact, a greater contributor to acidity than acid rain. And yet when you asked a number of questions at the end there, the word fertilizer was not among those questions.

Aren't there some questions that should be asked about the use of fertilizer, and aren't there some public policy decisions on which we should be biting the bullet, so to speak, about the use of fertilizer, if fertilizer adds more to the problem of acidification than does acid rain?

Dr. JACOBSON. Farmers resolved that problem for decades by adding lime to cultivated soils, so in cultivated soils that problem is taken care of.

Mr. SCHEUER. Congress, now, still sets the ground rules, whether it is for utilities or industry, or farming for that matter, and we will have to look at the overriding national interest and set the ground rules for each segment of our society and how they can function.

Now, if the use of fertilizer is a major contributor to acidification of the soil, perhaps indirectly to the acidification of our lakes and rivers, maybe there are some limitations in the national interest that we ought to place on the use of fertilizer. Is this an area we should be looking into?

Dr. JACOBSON. I think the best way to answer that question would be to quote from some eminent soil scientists. There are two aspects for the acid rain problem in vegetation. One is, what happens to the soil, and how it affects productivity, and the other aspect is what happens to the aboveground organs when contacted by acid rain? You refer to the soil part. Agricultural soils are selected because they are fertile and have a high neutralizing capacity. In addition, lime is added.

Here is a quote from a recent manuscript by Professors Jones and Suarez: "The possibility of crop yields being affected by too much or too little soil or air sulfur is slim."

Another quotation from an article by Professor Olson: "There is reasonable cause for doubt that the elevated levels of acid deposition will have any serious damaging effect on agricultural soils."

Mr. SCHEUER. What I am asking is, will the use of fertilizer in agricultural soils have a damaging effect on acidity in terms of its effect, the effect of too much acidification, on rivers, lakes, forest growth, damage to structures, and so on?

Mr. JACOBSON. Yes. The answer is, to streams and lakes that are below agricultural areas, definitely, yes.

Mr. SCHEUER. I just performed a miracle. Not only have I made industrialists mad at me, and utilities mad at me, and the automobile manufacturers mad at me; now I have made the farmers mad at me.

I yield to my colleague, Mr. Carney, so they can be mad at him, too.

Mr. CARNEY. Thank you very much, Mr. Chairman.

Here in the mountains I would assume there is very little agriculture going on because it is mountainous, here where your lakes are affected. If you take a lake in this area, I would assume the acidity changes in lakes in the higher parts of the Adirondack Mountains would almost exclusively be caused by acid rains and not by fertilizer runoff. Would I be correct in that assumption?

Dr. JACOBSON. I think it would be best for me to defer to other members of the panel to speak to the lake effects.

Mr. CARNEY. Your expertise is the adverse effect on agriculture and on forestry. Acid rain is a product of the combustion of hydrocarbons and so is the greenhouse effect of byproducts of combustion of hydrocarbon. Have you done any research, or can you comment on the negative, positive, or no reaction to agriculture, or to forestry from the greenhouse effect?

Dr. JACOBSON. By greenhouse effect, you are referring to the production of carbon dioxide from the combustion of fossil fuels and the increase in CO_2 content of the atmosphere that may, in turn, cause a change in climate. Is that right?

Mr. CARNEY. That is right.

Dr. JACOBSON. There is a fair amount of research going on on that subject, and it is fairly well documented that the carbon dioxide content of the planet is slowly increasing. However, there is not yet a consensus of opinion on at which point these increases in CO_2 content will have a significant effect on the climate of the Earth and hence on the productivity of our forests and farms; so it isn't quite clear how long it will take for that.

Mr. CARNEY. Would you assume it would have a negative effect on forestry and agriculture?

Dr. JACOBSON. No, sir, not necessarily. It depends on the region of the Earth. When you shift climate, regions that currently are arid or dry may receive rainfall and their productivity may be improved. Regions that now have ample rainfall may have reduced rainfall and their productivity would be decreased.

Mr. CARNEY. How about the effect on the atmosphere from the combustion of hydrocarbons in relation to the Sun's role in forestry and agriculture?

Dr. JACOBSON. I am not sure specifically what your question refers to. In terms of the receipt of solar radiation onto the surface of the Earth?

Mr. CARNEY. The effect of smog, et cetera, on agriculture. Has there been an identified effect of smog on agriculture and forestry?

Dr. JACOBSON. I don't believe there has been an identified effect, although obviously visibility in the Eastern United States has reduced over recent decades, and there is a decrease in solar radiation, but I don't think its secondary effect on agricultural or forest productivity has been measured.

Mr. CARNEY. I will ask you to answer this next question with one word: If you had the choice right now, given all your knowledge and all the research we have, to pick a pH value for the rain and snow in the United States where would you like to see that?

Dr. JACOBSON. Are you referring to an annual average pH that would be relatively innocuous for vegetation?

Mr. CARNEY. That is correct.

Dr. JACOBSON. I would say at the present time, for vegetation, the balance of positive and negative effects is such that, there is no net detriment at the present time.

I would be extremely concerned, however, if there were any increases in acidity over the current levels.

Mr. CARNEY. Thank you very much.

Mr. SCHEUER. Congressman Gregg?

Mr. GREGG. Doctor, I guess I didn't understand why you finally came down on the issue of forest products. There is a recent study done by a Canadian forestry that indicated acid rain significantly affected their products. Can you give a brief statement of what your assessment is of that study and whether or not you agree with that conclusion?

Dr. JACOBSON. My experience and expertise is the effects on agricultural crops. I think I would have to defer to Dr. Raynal.

Mr. SCHEUER. Congressman Mitchell?

Mr. MITCHELL. Thank you, Mr. Chairman. I appreciate, Doctor, your making scientific observations, but you make so many qualifications and so many conflicting statements that it is almost impossible for a layman to draw any conclusions.

I want to see if I can simplify it just a little bit for those of us who are not in the scientific community.

If there were no coal-burning plants dumping thousands of tons of pollutants into our atmosphere each year, wouldn't our lakes be far more healthy and wouldn't our soils be far more productive?

Dr. JACOBSON. The first part of your question, the answer would be probably yes. The second part of the question, probably no. That is to say, the effects on certain lakes and certain locations, it is fairly clear. The effect on soils, there is no agreement at all.

Mr. MITCHELL. The jury is out on soil.

Dr. JACOBSON. Totally out and will be out for a long time to come.

Mr. MITCHELL. Maybe whoever set up this great planet of ours factored in acid rain someplace, and he thought we would have better crops and better environment if we could dump tons of pollutants on our soils. Do you think that is true to assume?

Dr. JACOBSON. I think that is an oversimplification.

Mr. MITCHELL. I think we have to simplify it a little bit, Doctor, or we are not ever going to get an answer. That is the point I am making.

Dr. JACOBSON. The problem with simplification is that you might come up with the wrong answer.

Mr. MITCHELL. We surely haven't come up with the right one yet, because every year it gets a little bit worse.

Thank you, Mr. Chairman.

Mr. SCHEUER. Congressman Martin?

Mr. MARTIN. Very briefly, Doctor, on your test of 28 crops where the yield was reduced in 5, increased in 6, and 17 remained the same, it is pretty inconclusive one way or the other, but what were the circumstances, and what was the pH and what was the acidity of the rain to which these crops were exposed in your tests? Was it such as we had here in Lake Placid last night, or more or less?

Dr. JACOBSON. Let me comment on your first statement. You said the results of the test were inconclusive. I would disagree. I think the results of that particular test were quite conclusive. I think a farmer who was growing a crop whose productivity would be reduced—one of the ones that might be one of the six—would say that is very conclusive, and likewise a farmer growing one of the ones increased would say that was conclusive.

Mr. MARTIN. How about the level of acidity?

Dr. JACOBSON. These tests were performed, not by my laboratory, so I am referring to a published article in this. My recollection is that the levels of acidity from below those occurring now through the range that do occur now, to concentrations that are lower than occur now, and so the results that they have provided are from an experimental situation. You must understand that we do not know exactly how to relate the conditions of these experiments to those that occur in the field in the Northern United States.

That is one of the main reasons why the scientists equivocate, why there are differences of interpretation, why it is necessary to continue research on this subject.

Mr. MARTIN. You don't feel, Doctor—in your testimony you speak to this—you don't feel it is significant to also attach an addendum of the practical circumstances as they might relate to the real world rather than the test? You don't think that is significant?

Dr. JACOBSON. That is very significant, and that is why in answer to each one of my questions, I have stated research needs, and so the reason for taking these initial results and requiring additional verification and validation of the initial observations, in order to exactly do that.

Mr. MARTIN. The research is obviously already done. Perhaps you could submit to the committee, as an addendum to that portion of your graphic example, the circumstances, under which, this test was done.

Dr. JACOBSON. I would be happy to do that.

[The information Dr. Jacobson provided for the record follows:]

The research referred to earlier in my testimony was performed at the Oregon State University Agricultural Experiment Station in cooperation with the EPA Corvallis Environmental Research Laboratory. The objectives of the study were to determine the susceptibility of different crops to reductions in yield by simulated acidic rain. Simulated rain solutions were prepared with sulfuric acid and other ions to pH values of 4.0, 3.5, and 3.0 and compared to a control at pH 5.6. These solutions were applied to plants grown in pots in outdoor chambers for 1.5 hours/day, three days per week.

The results of this study should be viewed as a useful first estimate of crop susceptibility. They cannot be used as a conclusive demonstration of the effects of actual acidic rain on crop productivity as the authors recognize.

In their words: "Caution should be used in drawing conclusions from these data. They were obtained by subjecting potted plants to simulated sulfuric acid rain in field exposure chambers rather than to ambient rain under field conditions. The results pertain to a single growing season, a particular soil, and a particular location; thus, reproducibility of results has yet to be demonstrated. Interactions with air pollutants, other contaminants, or various environmental factors could affect the results. Interpretations of the data should be viewed as hypotheses to be tested under different conditions." (J.J. Lee, and G. E. Neely, 1980. Sulfuric acid rain effects on crop yield and foliar injury. EPA-60013-80-016. NTIS, Springfield, VA 22161).

The authors also state: "Since conclusions drawn from results of this study only pertain to its specific experimental conditions, further research is obviously needed before general statements regarding acid rain effects on crop quality and yield can be made." (C. J. Cohen, L. C. Grothaus, and S. C. Perrigan. 1981. Effects of simulated sulfuric acid rain on crop plants. Special Report 619, Agricultural Experiment Station, Oregon State University, Corvallis, Oreg. 97331).

Mr. GREGG. Could you tell me what crops grew well, so I will know what to plant next year?

Dr. JACOBSON. The difficulty with publishing initial results of this sort is that there is an assumption on the part of those who read it that, therefore, this crop under all circumstances, this crop will be increased and the others decreased. That would be premature.

Mr. MARTIN. You made a statement, Doctor, that we clearly need more research, and you certainly amplified that in your remarks.

How long do you estimate it is going to be before you would be satisfied with the evidence and we can take some action based on sound scientific data? How long will it be? Three years? Ten years? Fifteen?

Dr. JACOBSON. You are going to be very upset with my answer, I am sure.

Mr. MARTIN. I can tell.

Dr. JACOBSON. It is a very simple question but do you refer to all crops of the country? Do you refer, sir, to all soils and climatic regions of the country? Do you require this information to be of such a rigorous nature that all of the experts in this particular field would agree?

Mr. MARTIN. They will never agree.

Dr. JACOBSON. I couldn't even estimate how long it would take. This is the problem.

Mr. MITCHELL. An infinite period of time. They will never agree.

Dr. JACOBSON. We need to define what the requirements are for making policy decisions within each one of the subareas. With what degree of certainty do we need to know the answers to these questions? Without some feeling from you on this, I am hard-pressed to provide an answer.

Mr. MITCHELL. You have done a good job of outlining the parameters of the problem, but can you give us some time? Can we get some answers in 3 years, or 5 years?

Dr. **Jacobson**. You are certainly going to get some answers in 3 or 5 years, but there still will be arguments between experts. There still will be differences of opinion. Do not expect unanimity after 3 or 5 years.

Mr. **Mitchell**. I don't think you will ever get unanimity.

Mr. **Carney**. Will you yield?

Mr. **Mitchell**. Yes.

Mr. **Carney**. To give everyone a fair shake, I think we should move on to the other witnesses.

Doctor, if you ever get bored with research, you should go into politics. You have an uncanny ability to answer a question like a politician.

Dr. **Jacobson**. As you are a politician, Mr. Carney, I take that as a compliment.

Mr. **Scheuer**. Thank you very much, Dr. Jacobson.

We will now hear from Dr. Mohnen.

Mr. **Mohnen**. Honorable Congressmen, I think I can be understood by standing up, since I have to show some graphs. I have with me my colleagues, Dr. Jerre Wilson and Dr. John Kadlecek, who have helped put together this presentation.

I will make two points and refer for the rest of my testimony to the written submission.

First, one should understand that we are living in an "airshed" that has been "effectively saturated" with processed sulfur and nitrogen compounds in rain. No matter how much you add to this airshed, one probably will not obtain a higher level of acid rain (wet deposition) within that airshed, but one will spread acid rain (wet deposition) further out.

How did we arrive at that conclusion?

As you can see, we show the Eastern half of the United States in the top picture. We then identify an area in the middle of the Adirondacks called Whiteface Mountain.

We then measure (as part of an official program called MAP3S, in connection with NADP) the wet deposition over a period of years. We then ask, where has the air been for the past 2 days prior to raining at Whiteface Mountain. This analysis can be done at this time, in order to obtain further information on differences between the Midwest, Ohio Valley, and the Canadian Great Lakes sector. We have shaded the one part blue (the Midwest Ohio Valley) and the other part red (Canadian-Great Lakes).

We now ask for the percentage of rain that is being delivered by air masses from the Midwest Ohio Valley on an annual basis. The number is 56 percent of the annual precipitation which is being delivered to Whiteface Mountain from the Midwest Ohio Valley sector, and 26 percent is being delivered from air masses that have spent the past 2 days in the Great Lakes-Canadian area.

We then ask how much polution-related material such as sulfur and nitrogen, has been deposited with this rain.

To make a long story short, roughly 60 percent of the precipitation; 60 percent of the acidity; 60 percent of the sulfate; and 60 percent of the nitrate comes from this Midwest sector.

On the other hand, 26 percent of the precipitation and 31 percent of the acidity comes from the Canadian sector, in spite of the well-recognized fact that the Canadian Great Lakes area has much less emissions than the Midwest Ohio Valley area.

In order to test this hypothesis further, we have looked at a station on the upwind side of the Midwest Ohio Valley. In this instance it is Champaign, Ill.

The same analysis is performed. In this case 70 percent of the annual precipitation comes from the sector that is upwind of the Ohio Valley and with it comes 70 percent of the annual acidity; 65 to 70 percent of the annual sulfate and nitrate.

From these data we conclude that in the Eastern United States we have a "saturated airshed" with respect to acid rain. There is always enough pollution related material that can be converted. It is not only the amibient concentration of poilutant material that determines the wet deposition. There are other factors that govern the transformation from sulfur precursor gases into "acid rain."

What kind of consequences does that finding have? Assume this column to represent the emissions in one part of the country. The problem is to establish a source-receptor relationship so that one can ultimately tell a source by how much it has to reduce its emission in order to yield a desirable reduction at the receptor side, such as the Adirondacks.

For example consider a reduction of emissions by 50 percent. We would expect, under this scenario that the resulting impact will also be reduced at all distances by the same amount—50 percent.

However, the results I have presented here do not support the above expection. In other words, most scientists now agree that there is no linear relationship between reduction of emission and the equivalent precise same amount of reduction in wet deposition, in acid rain, at all sites.

Mr. MITCHELL. Could you repeat that statement, Doctor?

Dr. MOHNEN. Most scientists now agree that a reduction of emission by 50 percent does not necessarily mean a reduction of acid-rain-related material by the same 50 percent at all receptor sites.

What we seem to see is the following: A reduction of emission by 50 percent will have a much less pronounced effect, within the area that I call the saturated airshed. But it will have a dramatic effect somewhere outside of the "saturated airshed."

Once we know the limits of the "airshed" and as future research improves our current understanding of transformation between emission and deposition regions, we can determine what emissions reduction will yield a sufficient reduction in deposition to the Adirondacks.

The scenario I presented here is based on field data. If you want to see an estimate of the current extent of the "effectively saturated airshed," then I refer you to the last slide, which is also in the written testimony. You will see that the normalized wet deposition, as we call it, extends all the way over the Eastern United States, extending into Canada. So certainly my suspicion at this time is that we have a "saturated airshed" over the Eastern United States, east of the Mississippi, down into North Carolina, up into Canada. Precisely where we will see improvements first, when we ask for a reduction in emission—we will see it first outside the "airshed."

Thank you very much.

[The prepared statement of Dr. Mohnen follows:]

BEFORE THE
CONGRESS OF THE UNITED STATES
HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON NATURAL RESOURCES
OF THE
COMMITTEE ON SCIENCE AND TECHNOLOGY

STATEMENT OF VOLKER A. MOHNEN, Ph.D.

Director, Atmospheric Sciences Research Center
Research Professor, Department of Atmospheric Sciences
State University of New York at Albany

September 18, 1981

My name is Volker A. Mohnen. I hold a Ph.D. degree in physics, with a minor in meteorology and astrophysics, from the University of Munich. I am currently the Director of the Atmospheric Sciences Research Center and a Research Professor in the Department of Atmospheric Sciences at the State University of New York at Albany and am actively involved in research in the fields of air pollution, air chemistry and related subjects such as acid rain. I am the author of more than 120 publications and reports dealing with those subjects. My curriculum vitae is attached hereto.

I am presenting this statement at the invitation of the Honorable James H. Scheuer, Chairman of the Subcommittee.

Introduction

The Atmospheric Sciences Research Center operates a field station at Whiteface Mountain, in the middle of the Adirondack Mountains, that has been designated by the Department of Energy as the Rural Precipitation Chemistry Center. This station is part of the MAP3S/RAINE network and has measured precipitation quantity and quality on an event basis since the fall of 1976. In addition, the Atmospheric Chemistry Section of the National Science Foundation, supports for the past four years a variety of our research projects relating to acid rain in general and to the causes thereof in particular. The Center's research efforts are confined to "mechanisms research" as opposed to "effects research". To this extent we have focussed our attention to the measurement of wet deposition, the identification of chemical and physical mechanisms governing the appearance of acidic material (and pollution-related material in general) in precipitation and to the role of clouds, fogs and dews in the overall transport and transformation of gases that eventually yield sulfuric and nitric acid in precipitation.

In the following section I shall assess the overall results for wet deposition in the Eastern United States with particular emphasis on the impact of air masses that have passed over areas with significantly different sulfur and nitrogen emission densities. The main result is that a "source-receptor" relationship between high emission density areas and wet deposition of pollution-related ions cannot be established at this time.

I shall also briefly summarize and assess the atmospheric models that have been selected by working group 2 of the US/Canada work group on Transboundary Air Pollution for establishing source-receptor relationships. My main findings are that none of the models adequately and realistically incorporate the overall transformation of sulfur and nitrogen bearing molecules into acidic materials. These models assume a linear transformation which has not been confirmed in the field. To the contrary, recent field experiments indicate the existance of very complex, non-linear transformation pathways that ultimately lead to wet deposition, i.e., acid rain.

The following support material is available from ASRC upon request to provide detailed insight on the above findings:

1) ASRC Publication 796. Wet Deposition in the Northeastern United States. J. Wilson, V. Mohnen and J. Kadlecek. December 1980.

2) Wet Deposition as Observed by MAP3S. J. Wilson, V. Mohnen and J. Kadlecek. Accepted for publication in _Atmospheric Environment_. 1981.

3) An Analysis of Spatial Variability of the Dominant Ions in Precipitation in the Eastern United States. J. Wilson and V. Mohnen. Submitted for publication in the _Journal of Water, Air, and Soil Pollution_. 1981.

4) Acidity in Air and Water in a Case of Warm Frontal Precipitation. A.L. Lazrus, P.L. Haagenson, G.L. Kok, B.J. Huebert, C.W. Kreitzberg, G.E. Likens, V.A. Mohnen, W.E. Wilson and J.W. Winchester. Presented at APCA Conference, Philadelphia, PA. June 1981. Session # 13.

I am deeply indebted to Drs. Jerre Wilson and John Kadlecek for their help in preparing this statement.

Acid Precipitation in the Eastern United States

The measurement of free hydrogen ion concentration in precipitation (pH) is not a trivial measurement, and its interpretation requires detailed information on:

- sampling location
- chemical and physical conditions of the surrounding terrain or surface
- sampling collection procedure for precipitation
- sample handling, etc.

The diagram in Figure 1 attempts to illustrate some of the informational needs that must be included with the publication of a pH value. Most measurements are made today on a weekly basis (such as in the National Atmospheric Deposition Program--NADP) or on an event basis (such as in the Multistate Atmospheric Power Production Study--MAP3S). An event is defined by the beginning and the end of precipitation. Modern collectors are normally closed and open only during precipitation through an automatic triggering device. This procedure will minimize contamination that arises from dry deposition of dust and wet debris. Precipitation samples can be collected by ground collectors or airborne platforms. Rain that fell trhough the last few meters of the planetary boundary layer might be of different quality than rain that was collected at a considerable height above ground. A ground collector can be located over ocean or over land, above or below a vegetation canopy, or in an open field. Precipitation can be collected from above (mountain tops, etc.)

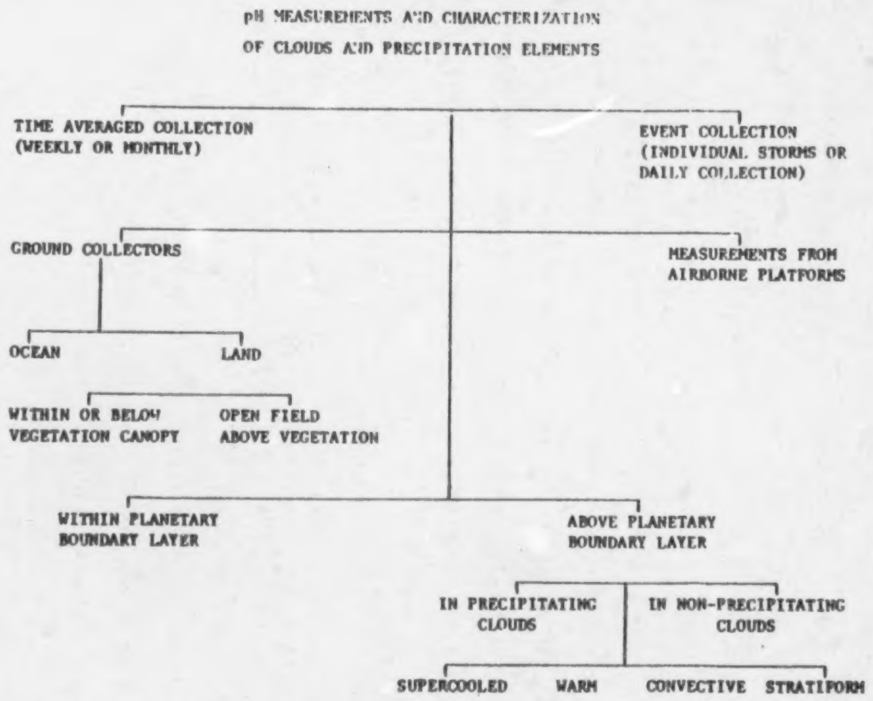
pH MEASUREMENTS AND CHARACTERIZATION
OF CLOUDS AND PRECIPITATION ELEMENTS
TIME AVERAGED COLLECTION (WEEKLY OR MONTHLY)
EVENT COLLECTION (INDIVIDUAL STORMS OR DAILY COLLECTION)
GROUND COLLECTORS
MEASUREMENTS FROM AIRBORNE PLATFORMS
OCEAN
LAND
WITHIN OR BELOW VEGETATION CANOPY
OPEN FIELD ABOVE VEGETATION
WITHIN PLANETARY BOUNDARY LAYER
ABOVE PLANETARY BOUNDARY LAYER
IN PRECIPITATING CLOUDS
IN NON-PRECIPITATING CLOUDS
SUPERCOOLED
WARM
CONVECTIVE
STRATIFORM

Figure 1. pH measurement classification.

or below the planetary boundary layer. Most networks today that collect precipitation for long-term monitoring are based on weekly or event-by-event sampling from ground stations that are located in an open field with no hearby obstacles.

The pH value obtained from such collection sites might have regional representativeness. All values analyzed and reported here originate from such networks. A very strict quality control procedure exists for both MAP3S and NADP. One should keep in mind that the pH itself is insufficient to characterize precipitation quality. It is very informative to divide the ionic constituents of precipitation into three categories or components:

- o Soil-derived minerals Ca^{++}, Mg^{++}, Fe^{3+}, silicate ions, etc.
- o Sea salt Na^+, Cl^-, $SO_4^=$, plus small amounts of K^+, Mg^{++} and Ca^{++}
- o Atmospheric conversion products from sulfur and nitrogen bearing molecules, i.e., $SO_4^=$, NO_3^-, in addition to NH_4^+ and Cl^- (from hydrochloric acid) and, obviously, H^+

The dominant source of data is the Multistate Atmospheric Power Production Pollution Study (MAP3S). In this ongoing study, precipitation chemistry data are obtained on an event basis beginning in 1976 for the original MAP3S collection sites of:

o Whiteface Mountain/New York	(WFM)
o Ithaca/New York	(ITH)
o Pennsylvania State University	(PEN)
o University of Virginia	(VIR)

In 1977-1978 four more stations were added to the network located at:

o Champaign-Urbana/Illinois	(ILL)
o Lewis/Delaware (coastal site)	(LEW)
o Brookhaven, Long Island/New York (coastal site)	(BRO)
o Oxford/Ohio	(OXF)

The location of all MAP3S stations is shown in Figure 2.

The basic precipitation collector used by the MAP3S network during 1977-1979 was a wet deposition-only type designed by Battelle Pacific Northwest Laboratory as shown in Figure 3. This collector allows a relatively large exposed collection area while minimizing splashing and turbulence. An enclosed chamber enables samples to remain refrigerated until their removal for shipment. (A HASL type collector has been used since then.)

Field site operators measure pH, conductivity and sample volume before shipment to Battelle Pacific Northwest Laboratory for complete analysis.

To insure that an ionic balance was maintained between the major ions $SO_4^{=}$, NO_3^-, H^+ and NH_4^+ throughout the three-year period, ions or pairs of ions were analyzed for correlation or degree of association.

Figure 4 shows the balance between the four dominant ions, $SO_4^{=}$, NO_3^-, H^+ and NH_4^+. The linear correlation coefficient of 0.95 for Whiteface Mountain indicates that a significant portion of the sulfate and nitrate could exist in the form of sulfuric and nitric acid and the appropriate ammonium salts.

The linear correlation can further be improved by removing the soil components, indicated by Ca^{++} and Mg^{++}, from the cation summation as shown in Figure 4a. The correlation of 0.98 suggests an extremely good ion balance exists whenever boundary layer influences such as soil components can be reduced.

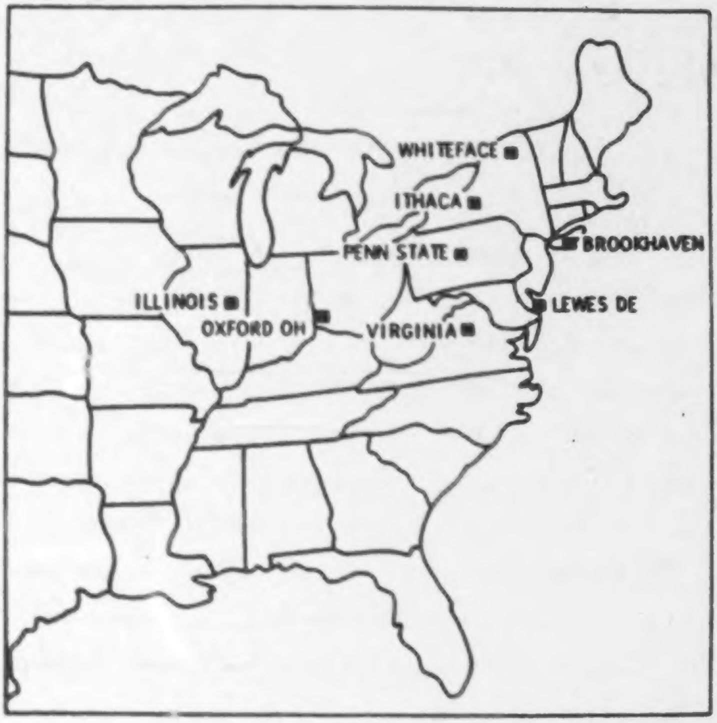
WHITEFACE
ITHACA
PENN STATE
BROOKHAVEN
ILLINOIS
OXFORD OH
LEWES DE
VIRGINIA

Figure 2. The MAP3S precipitation chemistry network site array. (MacCracken, 1979)

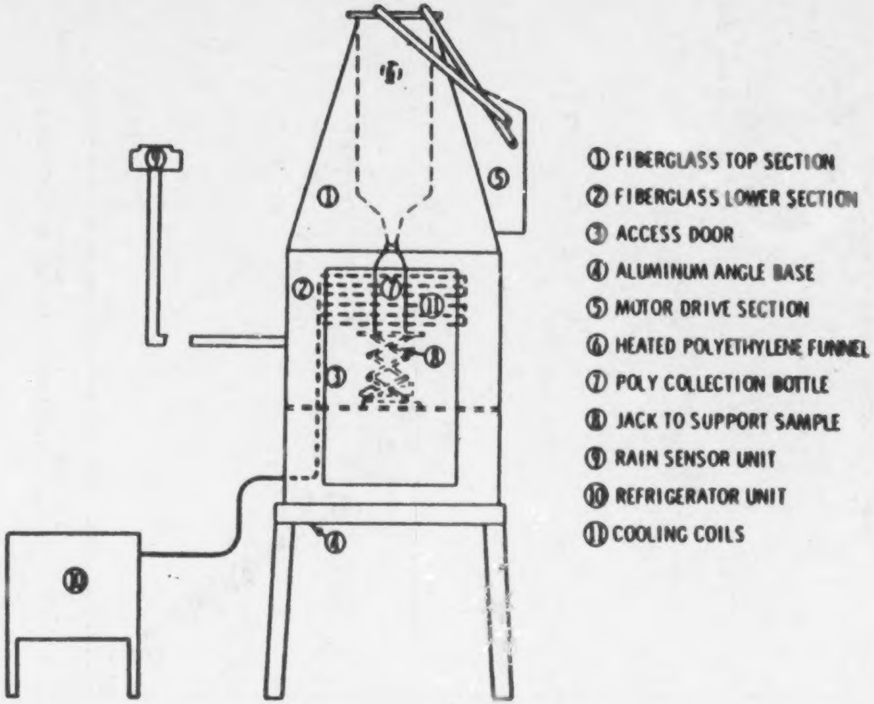
① FIBERGLASS TOP SECTION
② FIBERGLASS LOWER SECTION
③ ACCESS DOOR
④ ALUMINUM ANGLE BASE
⑤ MOTOR DRIVE SECTION
⑥ HEATED POLYETHYLENE FUNNEL
⑦ POLY COLLECTION BOTTLE
⑧ JACK TO SUPPORT SAMPLE
⑨ RAIN SENSOR UNIT
⑩ REFRIGERATOR UNIT
⑪ COOLING COILS

Figure 3. The PNL-designed precipitation collector used by the MAP3S precipitation network. (MacCracken, 1979)

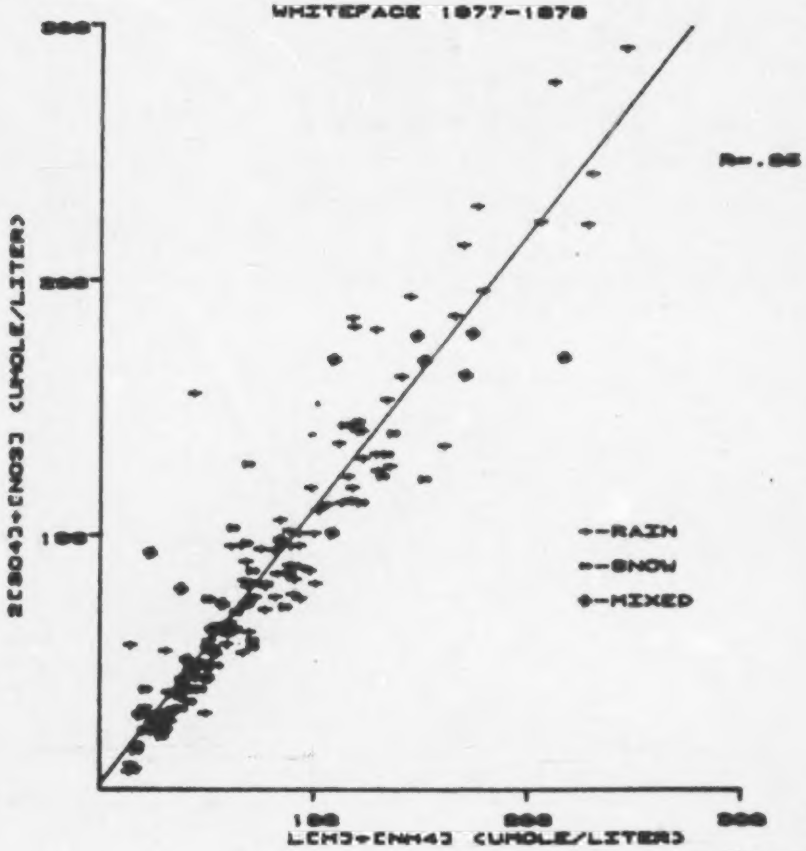

Figure 4. Hydrogen + Ammonium vs. 2(Sulfate) + Nitrate for Whiteface, 1977-1979.

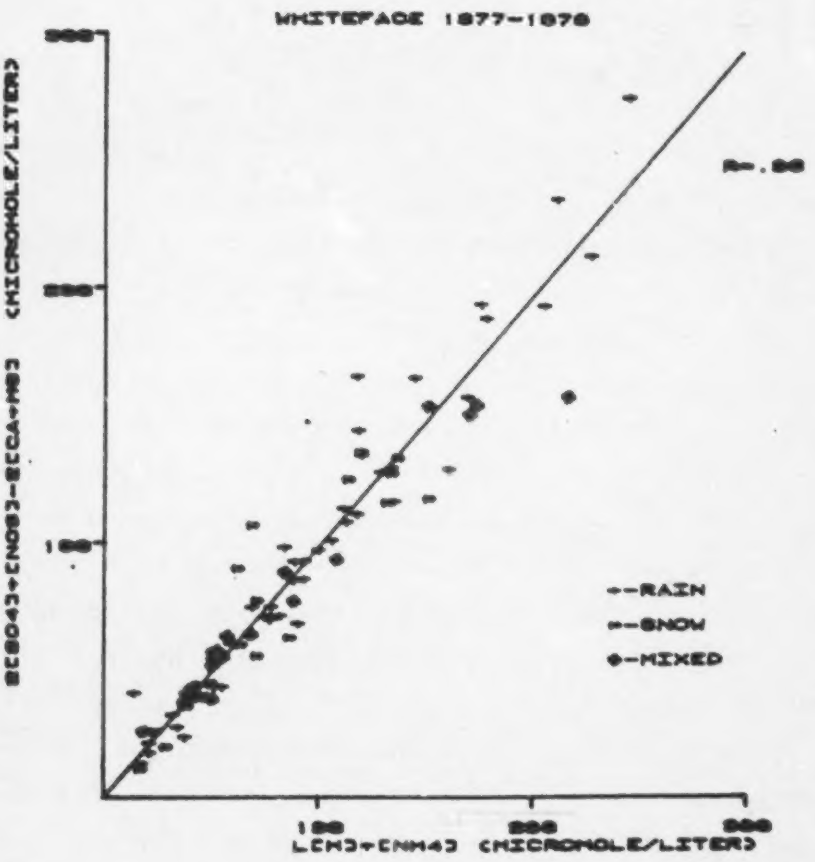

Figure 4a. Hydrogen + Ammonium vs. 2(Sulfate) + Nitrate - 2(Soil Components) for Whiteface, 1977-1979.

This procedure can also be used to determine the degree of dependency of the pH, or H^+, upon the other three major constituents. The concentration of H^+ in precipitation is bound primarily by $SO_4^=$, to a lesser extent NO_3^-, and finally NH_4^+. This conclusion applies to all types of precipitation for all three analyses and for the northeastern United States.

The results from Whiteface Mountain are identical to those obtained from Ithaca or from any other station in the MAP3S network. This does not mean that ammonia and hydrogen ions are the only positive ions and it does not mean that sulfate and nitrate are the only negative ions. There are, depending on the station location, a host of other anions and cations present. But eventually it is the correlation between ammonia and hydrogen ion versus sulfate and nitrate ions that best classifies the precipitation in the northeastern United States. If one goes west of 85° longitude, the picture may be totally different. There may be almost no free hydrogen ions found in areas where the soil is alkaline. This has been demonstrated very clearly in some of the NADP measurements.

Knowing that the ionic balance between hydrogen ion, ammonia, sulfate and nitrate is a good, although not a complete, indicator for acid precipitation, we now turn to the problem of the ion "deposition" versus back trajectory analysis.

I am now showing values primarily from the Whiteface Mountain station. This is an ASRC station in the center of the Adirondacks designated as the Rural Precipitation Chemistry Center. The 200 or so lakes that cover 10,000 acres and are allegedly without fishlife are mostly located in the high peak area (2,000 feet and above) in the vicinity of Whiteface Mountain.

The other results that I am discussing here will be from the Illinois site. One can, therefore, see data from the western end of a major emission region and the eastern end with the Tennessee and Ohio Valleys located in between. This will enable us to investigate the problem of whether or not and to what degree the Tennessee Valley/Ohio Valley contribute to the wet ion deposition of pristine areas such as Whiteface Mountain in the Adirondacks.

In general, I am reporting deposition values here. Obviously, there are two parameters: one is "concentration" of pollutant-related ions in precipitation; the other is "deposition" of pollutant-related ions. Effects researchers like to see deposition numbers because it is the amount of precipitation that brings down the pollutant material that eventually will lead to effects. One could analyze every event in regard to the air mass origin. This can be accomplished by calculating back trajectories for every event for the past two-day travel of air parcels prior to their arrival at Whiteface Mountain and Illinois. In that sense, one can then see whether or not Canadian air (air that has passed during the past two days over Canada) shows a different ion deposition than air that has spent the past two days in the Midwest/Ohio Valley.

To this extent, the Air Resources Laboratories' Atmospheric Transport and Dispersion Model (ARL-ATAD) was used to develop a trajectory climatology in conjunction with the precipitation chemistry at the Whiteface Mountain and Illinois sites. Trajectories were calculated for all of 1978 and 1979 and weighted by precipitation amounts during every six-hour period to determine a dominant direction or origin of air mass for each MAP3S precipitation event. Each event was then classified in one of twelve sectors covering 30° each. Only the final two days (48 hours) of approach trajectory end points were considered. This allowed differentiation between so-called "Ohio Valley/ Midwest" and "Canadian/Great Lakes" air masses. The so-classified wet ion deposition is plotted as a function of trajectory sector in Figures 5 through 7.

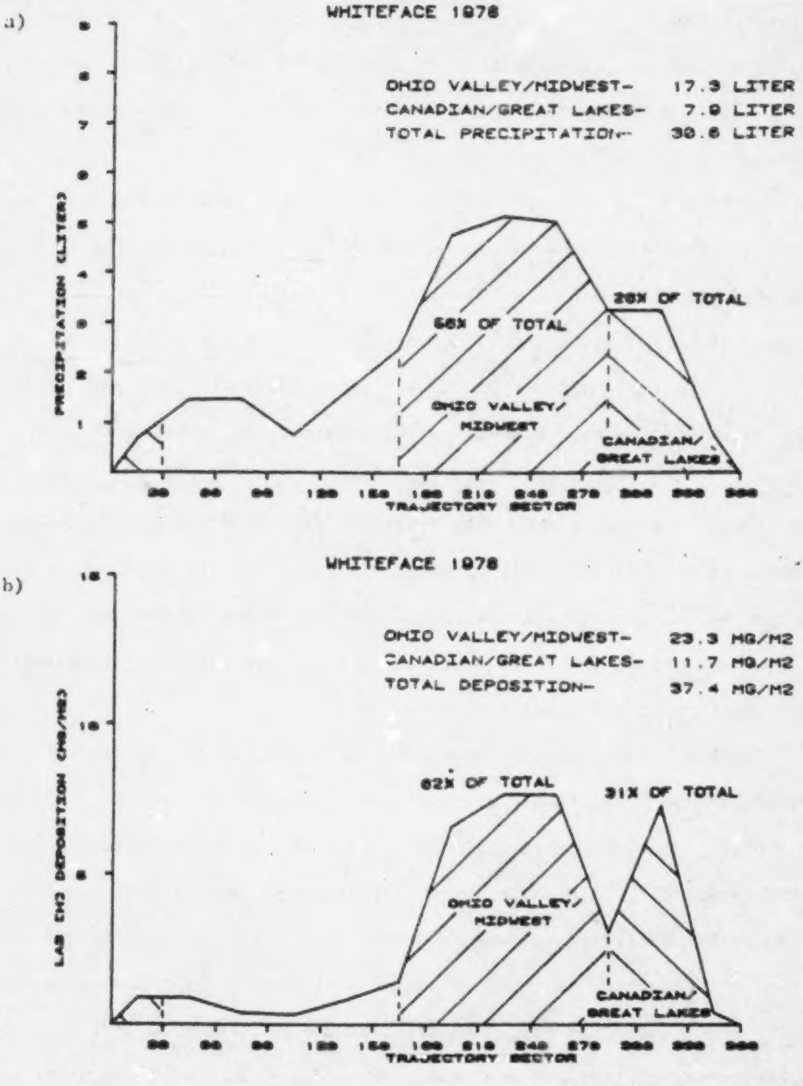

Figure 5. a) Precipitation volume, and b) Free hydrogen ion total wet deposition per 30° trajectory for Whiteface, 1978.

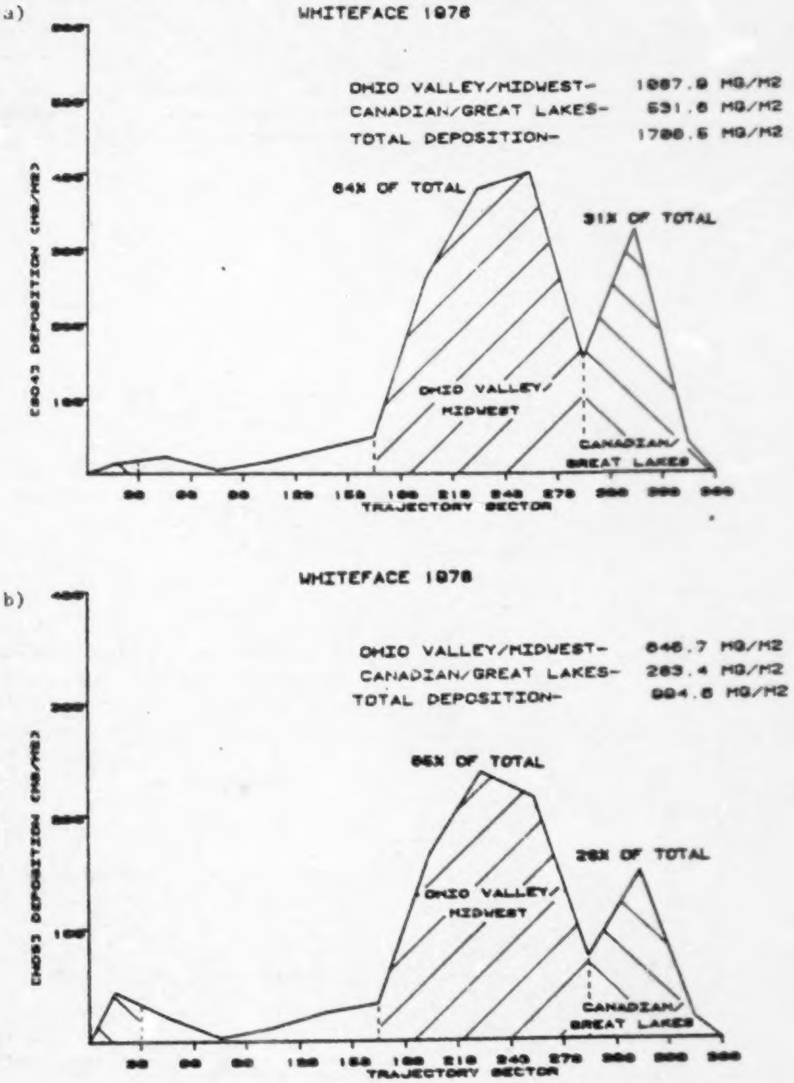

Figure 6. a) Sulfate, and b) Nitrate total wet deposition per 30° trajectory sector for Whiteface, 1978.

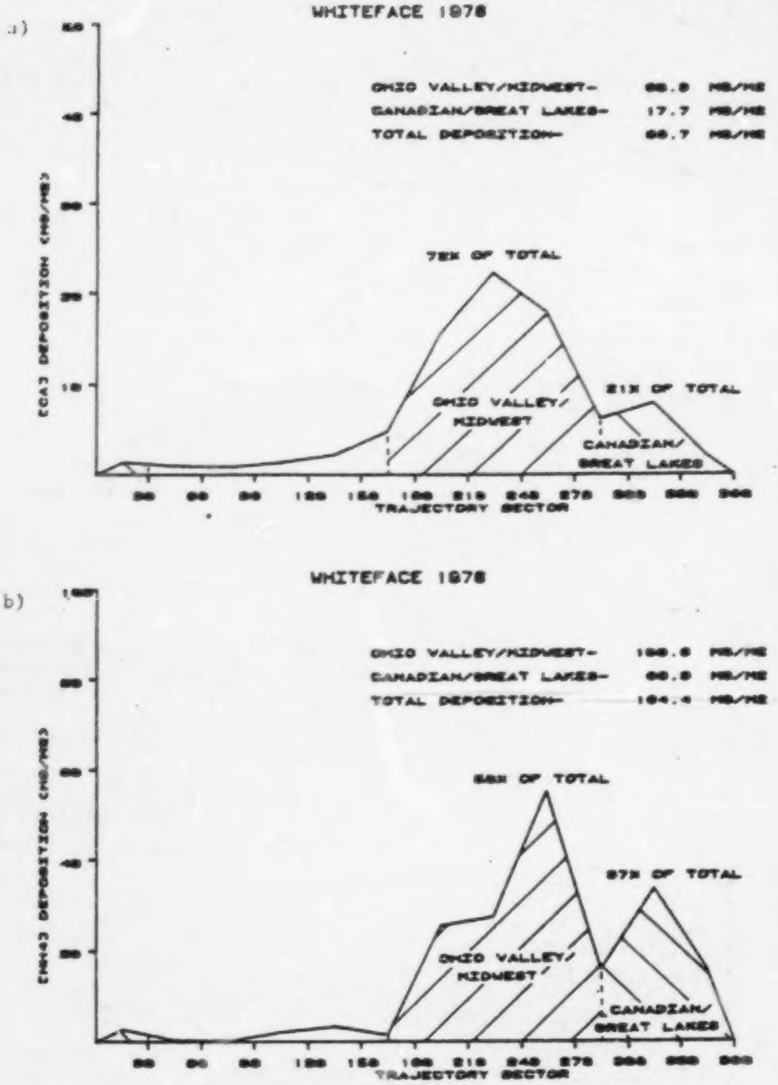

Figure 7. a) Calcium, and b) Ammonium total wet deposition per 30° trajectory sector for Whiteface, 1978.

The Ohio Valley/Midwest events were defined as those having their origin in the sector 165° through 285°, while the Canadian/Great Lakes events were designated by the sector 285°-30°. The wet deposition directional patterns for all ions were found to closely follow the precipitation variability in every case. The wet deposition cumulative total of the Ohio Valley/Midwest sector was found to account for approximately 50-70% of the total wet deposition that could be classified into the 48-hour approach trajectories. Wet deposition from the Canadian/Great Lakes sector resulted largely from winter coastal storms in the form of snow or mixed precipitation. Even though ionic concentrations were generally lower for these events, the large values of precipitation sample volume resulted in almost 30% of the total wet deposition at Whiteface Mountain.

The same analysis procedure (ARL-ATAD model) was applied to the MAP3S precipitation chemistry for the Illinois site during 1978. Since large pollutant sources for SO_2, NO_x, etc., lie to the east or southeast of the Illinois station, one might expect to see a significant difference in the deposition pattern of pollution-related ions observed at Whiteface Mountain during the same year. The cumulcative wet deposition total at Illinois for these events is plotted in Figures 8 and 9 revealing a very interesting picture. Approximately 70% of the total precipitation for Illinois was found to be associated with the southwest approach sector. This is consistent with synoptic considerations whereby southwesterly flow normally precedes an approaching cyclone system and subsequent deposition events. The remainder of the precipitation was found to be essentially equally distributed over the various sectors with the exception of the 0-30° segment.

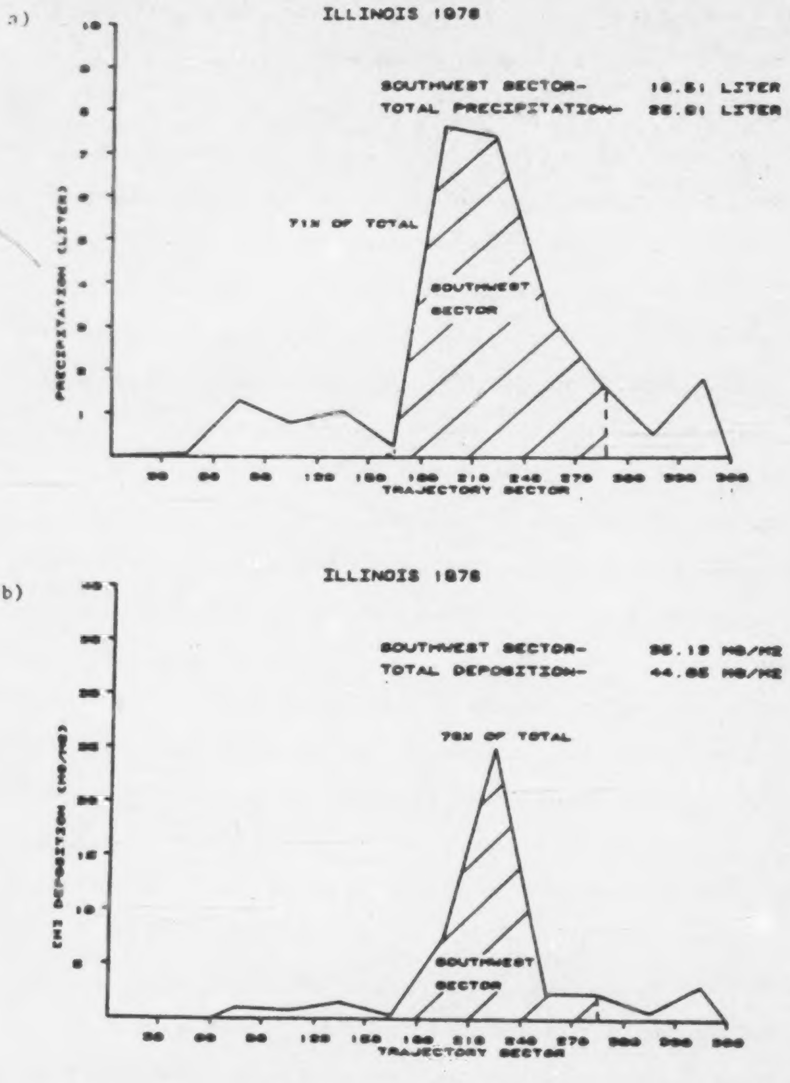

Figure 8. a) Precipitation, and b) Free hydrogen ion deposition per 30° trajectory sector for Illinois, 1978.

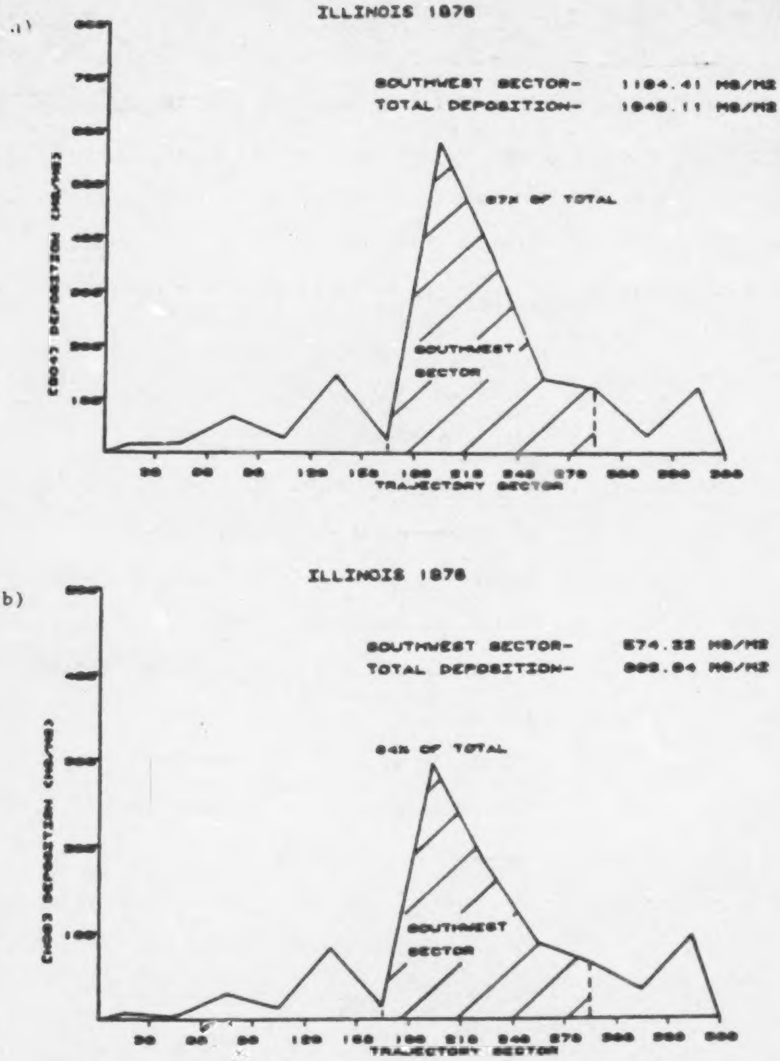

Figure 9. a) Sulfate, and b) Nitrate deposition per 30^{o} trajectory sector for Illinois, 1978.

Air masses approaching the Illinois site from the southwest were found to deliver about 70% of the total annual precipitation resulting in the deposition of approximately 70% of the major ions (Figures 8 and 9). One can again see that wet deposition of pollution-related ions depends primarily on the precipitation amount.

One might expect to see significant differences in precipitation chemistry as air masses from different regions arrive at a receptor site. However, the analysis shows:

	Whiteface Mountain (1978)
Midwest/Ohio Valley (160°-280° sector)	56% of the annual precipitation delivering
	62% of the annual $[H^+]$ deposition
	64% of the annual $[SO_4^=]$ deposition, and
	65% of the annual $[NO_3^-]$ deposition
Canadian/Great Lakes (280°-30° sector)	26% of the annual precipitation delivering:
	31% of the annual $[H^+]$ deposition
	31% of the annual $[SO_4^=]$ deposition, and
	28% of the annual $[NO_3^-]$ deposition
	Illinois (1978)
(160°-280° sector)	71% of the annual precipitation delivering:
	78% of the annual $[H^+]$ deposition
	67% of the annual $[SO_4^=]$ deposition, and
	64% of the annual $[NO_3^-]$ deposition

It is quite apparent that the precipitation volume, more than any other single factor, determines the amount of deposition for the three pollution-related ions, $[H^+]$, $[SO_4^=]$ and $[NO_3^-]$. The deposition of ions from the Midwest/Ohio Valley air and Great Lakes/Canadian air does not reflect the very significant differences in emissions that are located in these two regions. The Illinois results further substantiate the above conclusion. There seems to exist no simple, straightforward relationship between emission source(s) for acid precipitation precursor gas(es) and receptors of "acid rain," i.e., $[H^+]$, $[SO_4^=]$ and $[NO_3^-]$ ions. The chemical transformation pathway(s) seem to be complex and insensitive to a 48-hour back trajectory analysis presented here and based upon available meteorological and chemical information.

The concept of a "superbowl" (synoptic scale air shed) would explain to some extent the uniformity in directional variability of annual wet ion deposition in that the final products, i.e., acidic material is being rather evenly deposited over a very large region.

The actual wet deposition values for 1979 for sulfate and nitrate ions in milligrams per meter squared are listed for a few MAP3S stations in Figure 10. For example, we can see that 1908 milligrams of sulfate ions per square meter were deposited at Whiteface Mountain in 1979, versus 2,430 in Ithaca; 3,100 in Penn State; 2,400 in Oxford, Ohio; and 1,000 in Illinois. One is inclined immediately to jump to the conclusion that there exists a tremendous deposition gradient from west to east--1,000 mg/m^2 deposited in a year in Illinois; 2,000 in Ohio; 3,000 in Pennsylvania; over 2,000 in New York State (Ithaca); and 1,900 in the Adirondack Mountains.

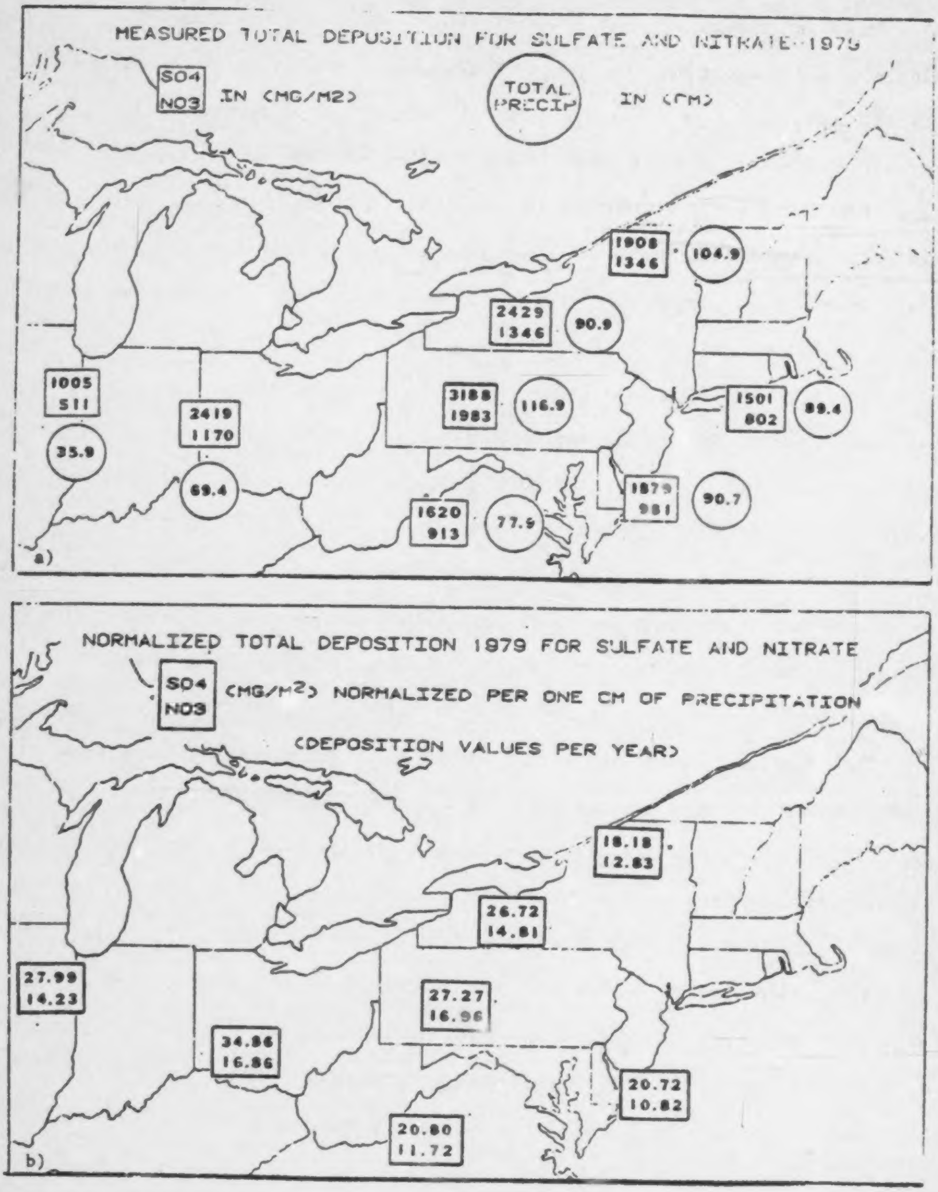
MEASURED TOTAL DEPOSITION FOR SULFATE AND NITRATE 1979
SO4
NO3
IN (MG/M2)
TOTAL PRECIP
IN (CM)
1908
1346
104.9
2429
1346
90.9
1005
511
3188
1983
116.9
2419
1170
1501
802
89.4
35.9
69.4
1879
981
90.7
1620
913
77.9
a)
NORMALIZED TOTAL DEPOSITION 1979 FOR SULFATE AND NITRATE
SO4
NO3
(MG/M^2) NORMALIZED PER ONE CM OF PRECIPITATION
(DEPOSITION VALUES PER YEAR)
18.18
12.83
26.72
14.81
27.99
14.23
27.27
16.96
34.86
16.86
20.72
10.82
20.80
11.72
b)

Figure 10. a) Measured, and b) Normalized sulfate and nitrate deposition, 1979

One can make the same (I might now add wrong and premature) conclusions in regard to a possible west-east deposition gradient by looking at nitrate ion deposition: 500 mg/m^2 per year at Illinois; 1,100 for Oxford; 1,900 for Penn State; 1,300 for Ithaca; and 1,300 for Whiteface Mountain. Obviously one important parameter has not been taken into account, namely the total annual precipiation amount. For example, Whiteface Mountain received 104 centimeters of precipitation in 1979, versus Illinois which received only 35.9 centimeters. Obviously, Whiteface Mountain received three times more precipitation than Illinois and should, therefore, also record a higher value for wet ion deposition. To circumvent the problem arising from different precipitation amounts for different sites, one has to normalize or standardize the wet deposition by the annual precipitation amount to obtain the normalized deposition of sulfate and nitrate ions per one centimeter of precipitation. We now see a different wet deposition pattern: 28 milligrams of sulfate ions per meter squared per year per centimeter of precipitation in Illinois, 34 at Oxford, 27 at Penn State, 26 at Ithaca and 18 at Whiteface Mountain (see Figure 10). There is no significant wet deposition gradient discernible anymore. This is a very important conclusion that further supports the concept of a "superbowl" for the annual wet deposition of pollution-related ions.

As mentioned earlier, several North American precipitation networks operate independently. It is, therefore, possible to correlate their results through proper analysis techniques. Two programs offering regional coverage, accessible data and reliable quality control are MAP3S and NADP. Even though MAP3S is event-oriented, while NADP collects weekly samples, their integrated ion deposition measurements are compatible when compared over time scales in excess of one year. Figures 11 and 12 show the location of the MAP3S

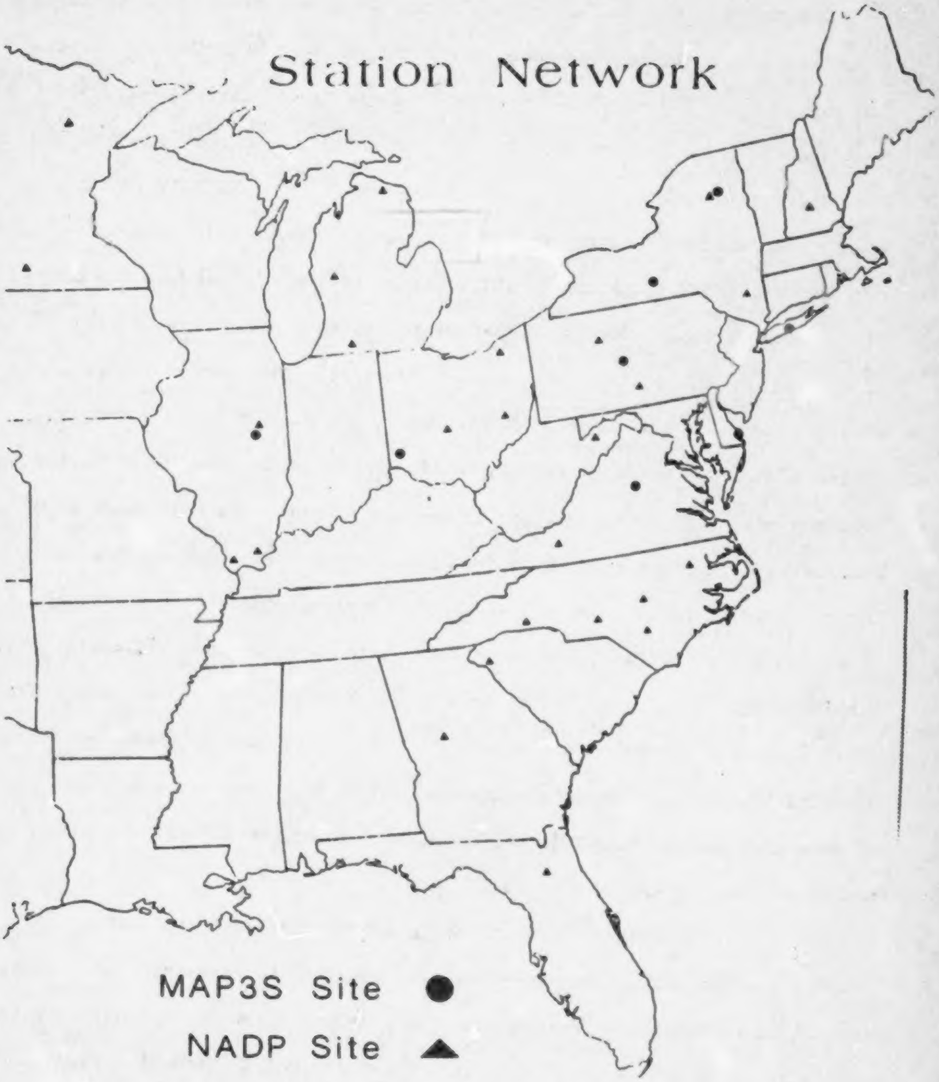
Station Network
MAP3S Site ●
NADP Site ▲

Fig. 11. MAP3S and NADP station network used for 1979 spatial deposition analysis

Figure 12

NADP Stations Used in 1979 Inter-Comparison Study

State	Site Name	Latitude	Longitude
Florida	Bradford Forest	29.97	82.20
Georgia	Georgia Station	33.18	84.40
Illinois	Bondville	40.05	88.37
Illinois	SIU	37.70	89.27
Illinois	Dixon Springs Ag. Ctr.	37.43	88.67
Michigan	U. Mich. Biological Sta.	45.57	84.68
Michigan	Kellogg Biological Sta.	42.48	85.38
Michigan	Wellston	44.22	85.85
Minnesota	Marcell Exp. Forest	47.50	93.47
Minnesota	Lamberton	44.25	95.32
Nebraska	Mead	41.09	96.50
New Hampshire	Hubbard Brook	43.95	71.70
New York	Huntington Wildlife	44.00	74.22
New York	Stilwell Lake-West Point	41.35	74.03
North Carolina	Lewiston	36.13	77.17
North Carolina	Coweeta	35.02	83.45
North Carolina	Piedmont Research Sta.	35.67	80.57
North Carolina	Clinton Crops Res. Sta.	35.01	78.28
North Carolina	Finley	35.73	78.68
Ohio	Delaware	40.28	83.06
Ohio	Caldwall	39.78	81.52
Ohio	Wooster	40.77	81.93
Pennsylvania	Kane Exp. Forest	41.55	78.77
Pennsylvania	Leading Ridge	40.55	77.93
South Carolina	Clemson	34.67	82.83
Virginia	Horton's Station	37.18	80.42
West Virgnina	Parsons	39.10	79.65

and NADP sites of the eastern United States. Total wet deposition was normalized per centimeter of precipitation as outlined earlier. To insure complete objectivity, spatial distributions of normalized wet deposition were analyzed using the Synagraphic Mapping System developed by the Laboratory for Computer Graphics and Spatial Analysis, Harvard University.

The resulting wet ion deposition patterns, normalized for one centimeter of precipitation, are shown in Figures 13-16. These objective analyses for the 1979 wet deposition of sulfate ($SO_4^=$), nitrate (NO_3^-), hydrogen (H^+) and ammonium ions again offer a surprising conclusion: there is no significant west-east gradient for the pollution-related ions $SO_4^=$ and NO_3^-. There exists a rather uniform gradient in almost every direction from major emission areas that are located in the Midwest/Ohio Valley. Furthermore, no maxima can be observed in the northeastern United States in these wet deposition values that would be indicative of increased wet deposition downwind of major emission areas. However, the effect of the Appalachian Mountains seems to be readily apparent, as evidenced by the strong wet deposition gradients in the northwest-southeast direction.

A slightly more complex picture emerges for the hydrogen ion deposition (H^+) in Figure 15. The free hydrogen ion deposition results from the contribution of various constituents including sulfuric acid, nitric acid, ammonium and soil-related components such as calcium and magnesium. Therefore, its spatial distribution can be expected to be more complex than the normalized wet deposition pattern of $SO_4^=$ or NO_3^- alone. This is indeed verified in Figure 16. Localized maxima in H^+ wet deposition are evident and a strong gradient emerges to the west of 85° longitude. One can speculate that soil-related material scavenged by precipitation might be responsible for the apparent change in free hydrogen ion deposition. This view is strongly supported by the normalized wet deposition emerging for the ammonium

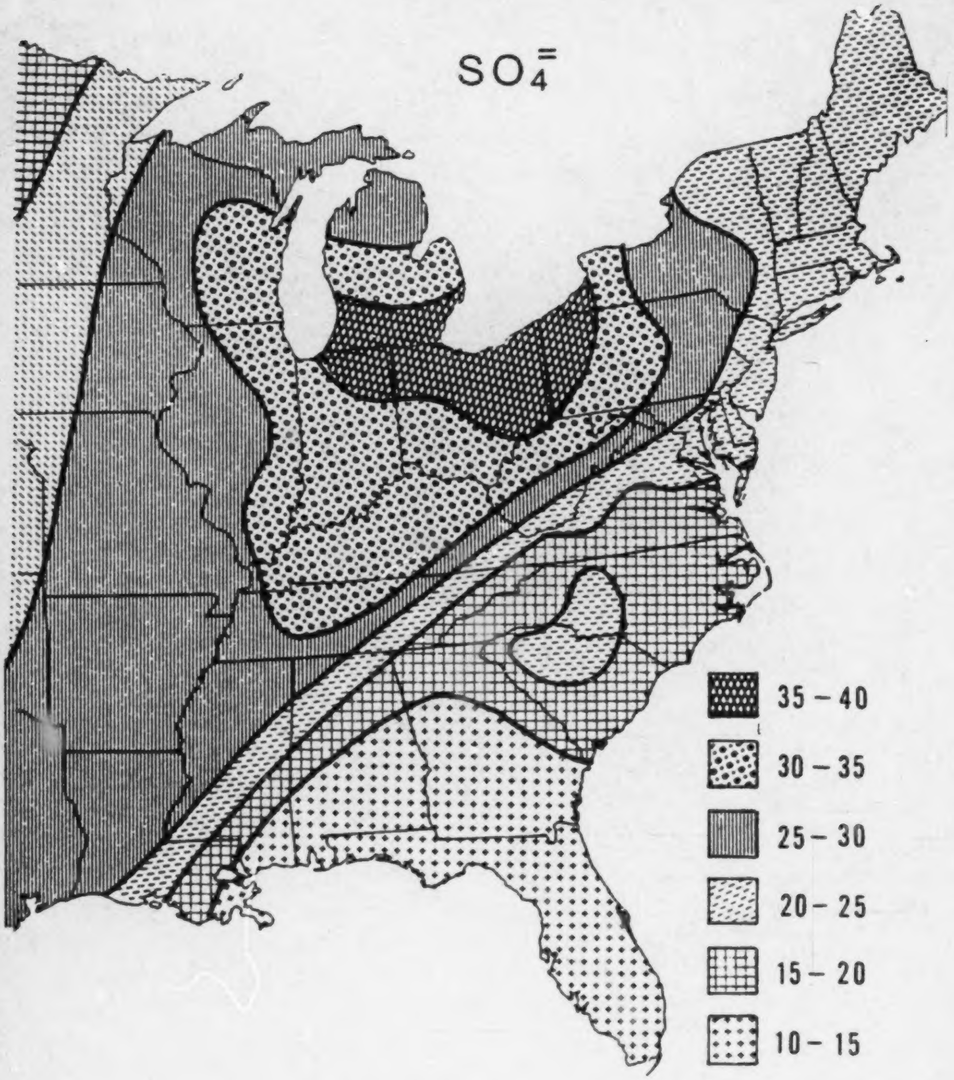
$SO_4^=$
35 – 40
30 – 35
25 – 30
20 – 25
15 – 20
10 – 15

Fig. 13. $SO_4^=$ deposition (mg/m^2) normalized per cm of precipitation for 1979

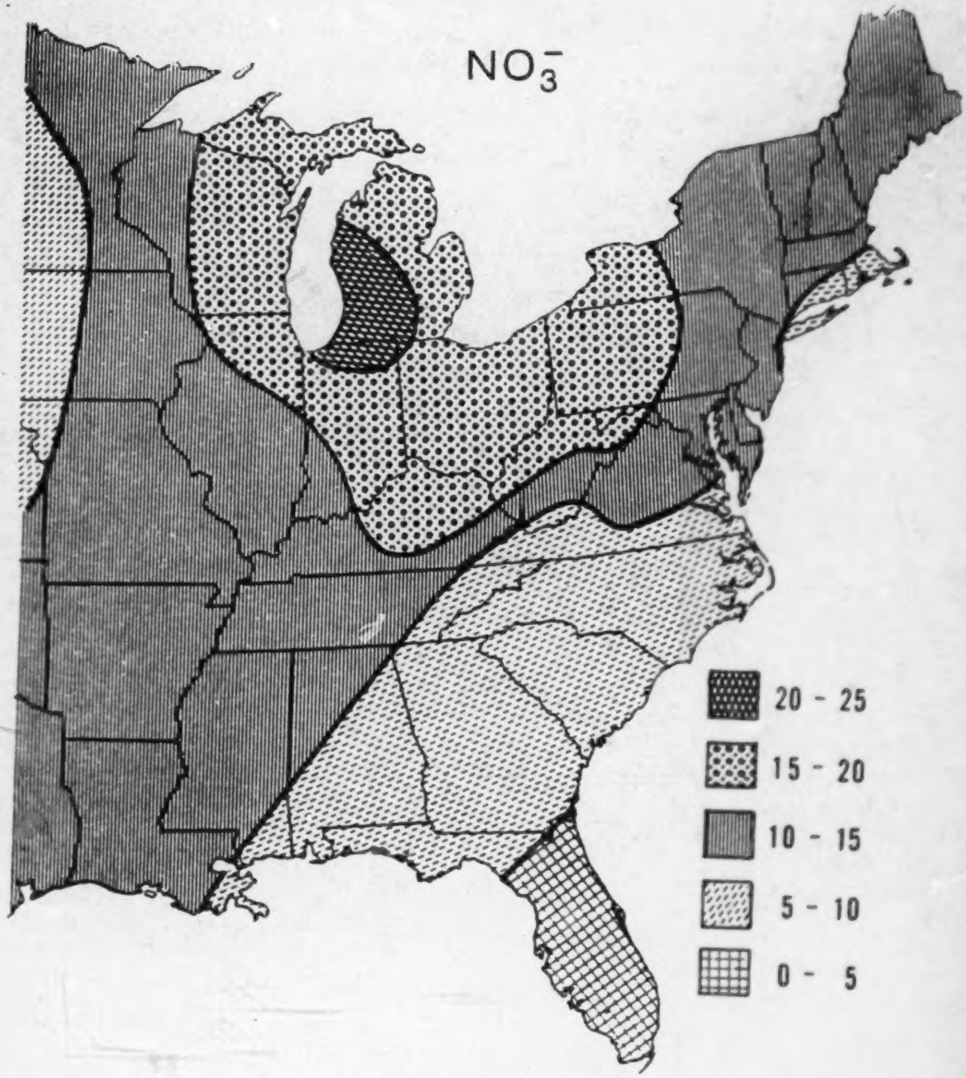
NO_3^-
20 - 25
15 - 20
10 - 15
5 - 10
0 - 5

Fig. 14. NO_3^- deposition (mg/m^2) normalized per cm of precipitation for 1979

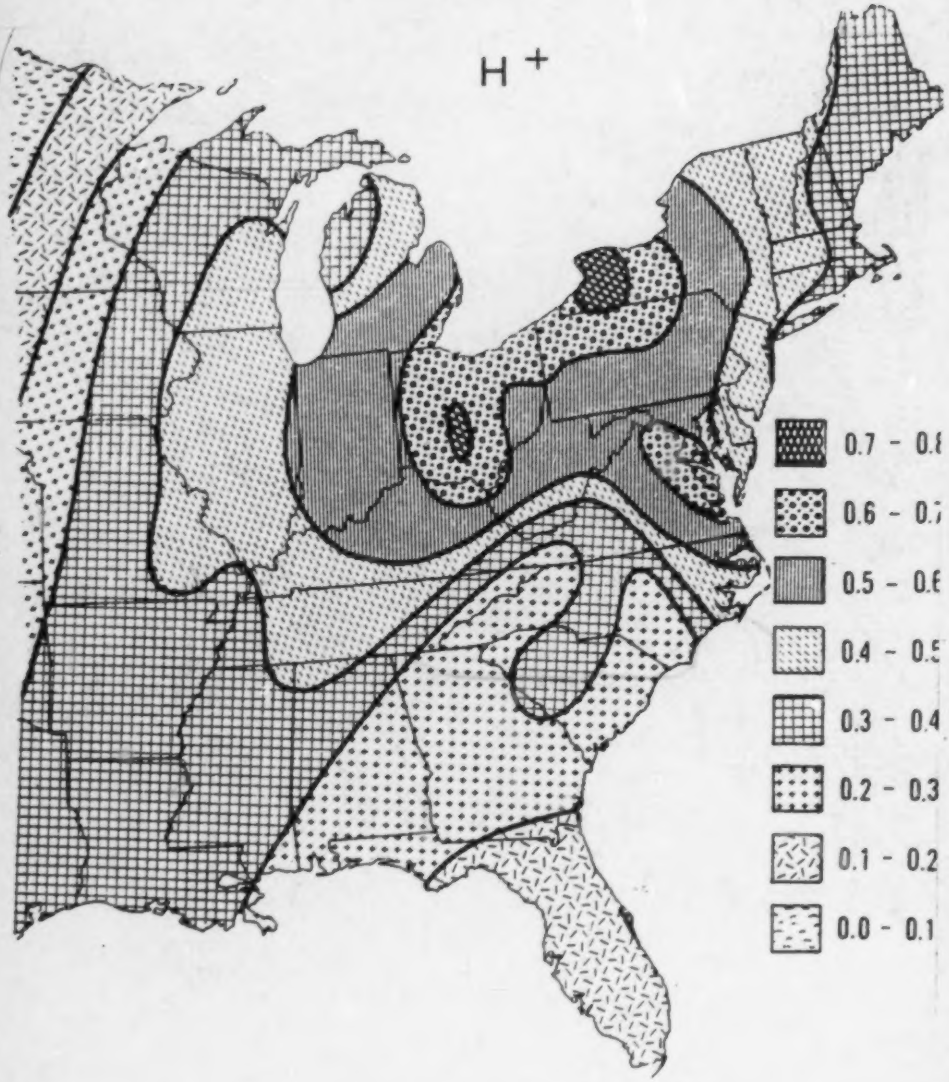
H +
0.7 - 0.
0.6 - 0.
0.5 - 0.
0.4 - 0.
0.3 - 0.4
0.2 - 0.3
0.1 - 0.2
0.0 - 0.1

Fig. 15. H^+ deposition (mg/m^2) normalized per cm of precipitation for 1979.

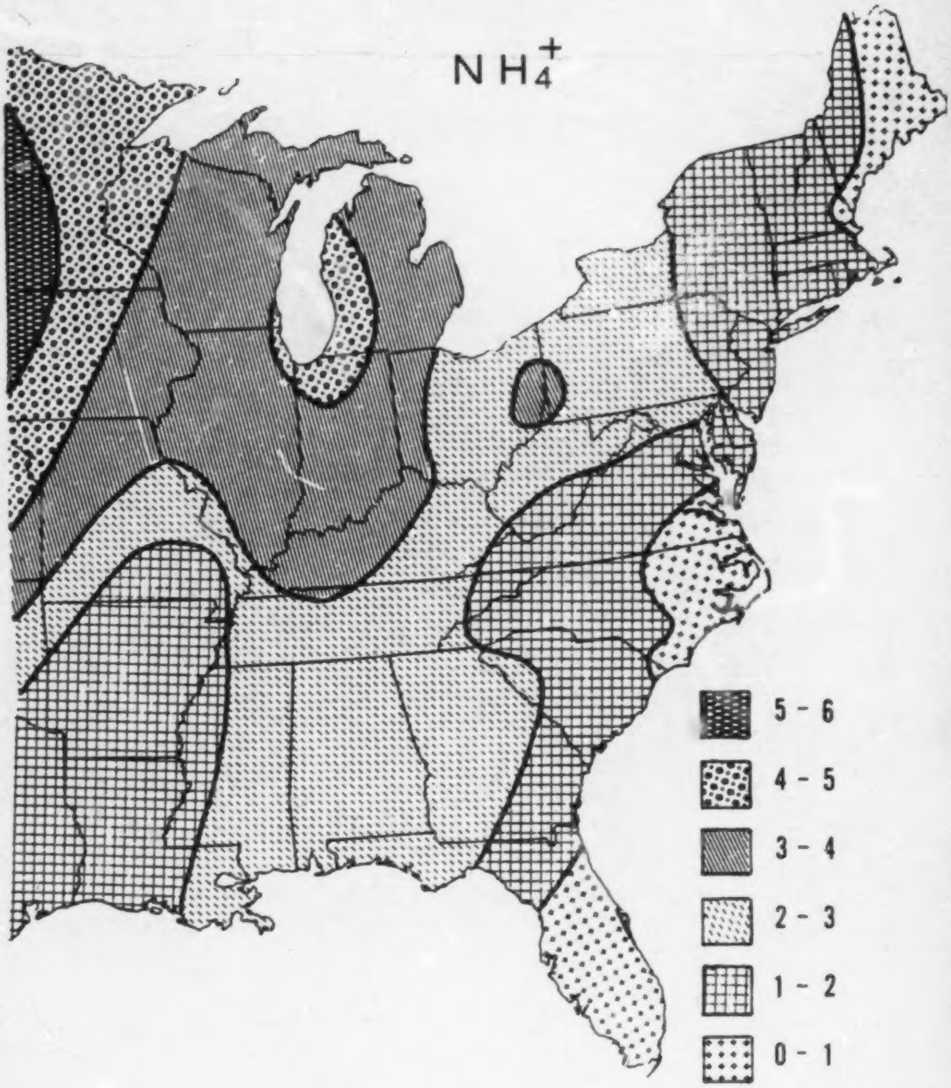
NH_4^+
5 - 6
4 - 5
3 - 4
2 - 3
1 - 2
0 - 1

Fig. 16. NH_4^+ deposition (mg/m^2) normalized per cm of precipitation for 1979 ion (see Figure 16). The normalized NH_4^+ deposition is largely a function of natural sources: increased NH_4^+ ion deposition to the west of 85° longitude correlates well with the decrease in free hydrogen ion deposition, since NH_4^+ acts as a "neutralizing agent".

Again, the concept of a "superbowl" can be used in the absence of a source-receptor relationship (emission-wet deposition relationship) to explain the relatively uniform west-east wet deposition distribution pattern for sulfate and nitrate ions.

I hope that I was able to demonstrate to you the complexity of acid precipitation. Indeed, we have a rather good knowledge of the emission of sulfur and nitrogen compounds. At the same time, we now seem to have good information on the wet deposition of nitrate and sulfate ions. But establishing a source-receptor relationship is very difficult. Classical meteorology, coupled with classical knowledge of air pollution and air chemistry, cannot identify the mechanisms and transformations at work. We are unable to understand the complex chemistry involved in transforming SO_2 and NO_x into sulfate and nitrates. It is slowly being revealed that the processes are more complex than anything we have dealt with in air pollution so far. It involves the chemical conversion of gases such as SO_2, NO_x, hydrocarbons, etc., into material such as nitric acid and sulfuric acid that are picked up by particles, cloud droplets and hydrometeors. The rate controlling step does not necessarily seem to be the absolute concentration of the precursor gases SO_2 and NO_x, but seems to be either meteorology available sunshine, the ratio of SO_2/NO_x or other parameters, or a combination of the above. With our limited knowledge today, the emissions seem to be essentially decoupled from the depositions. We simply need to know more.

The general motherhood statement, "What goes up must come down", certainly holds true. If this is all you are interested in, then we can stop right there and need no further research efforts. But if we want to know how much we have to reduce emissions in one part of the country to achieve improvements in wet deposition of pollution-related ions in another part of the country, then we will have to be more patient.

MODEL DESCRIPTION AND CRITIQUE

III. Model Description

General long-range transport models have been developed to study the transport of pollutants on a variety of scales. These sometimes complex models are often simplified by the use of sub-models which rely on parameterization to solve different aspects of the transport/chemical transformation problem.

The five models as shown in Table III-1 were selected by the Atmospheric Modeling Work Group (Memorandum of Intent on Transboundary Air Pollution, 1981) because they met the following criteria:

- operational
- numerically practical
- ability to expand as knowledge increases
- flexible geographical and temporal scale
- have been at least partially verified with observed data

Young and Nieman (1981) provide the following qualitative description for each of the five models:

- AES-LRT Model

  The Atmospheric Environment Service of Canada (AES) has developed and applied a Lagrangian box model to simulate ambient concentrations and deposition patterns of sulfur throughout eastern North America (Olson et al., 1979). The AES-LRT model is based on trajectories, at approximately 600 meters above the surface, which are calculated from each designated receptor four times a day using analyzed winds on the standard numerical weather prediction grid covering North America. As the air parcels follow the trajectories towards the receptor points, sulfur dioxide emissions (1976-1980), mixing heights and precipitation amounts along the path are determined from gridded arrays. The transformation and deposition processes are parameterized linearly. The concentrations at each receptor are combined to form daily, monthly, and annual average concentrations and depositions. An evaluation of the model is being conducted using measured data from several American and Canadian networks for 1978.

- OME-LRT Model

The Ontario Ministry of the Environment (OME) has developed and applied a simple statistical model to simulate long term ambient concentration and wet deposition patterns on a regional scale for eastern North America (Venkatram et al., 1980). The dispersion and removal of pollutants for the required meteorological parameters in the OME model are specified in terms of the statistics of these physical processes from wind and precipitation data. The source emission inventory corresponds to the year 1977. The OME model estimates compare quite favorably to measurements of annual wet deposition taken from Canadian and U.S. networks for 1977. The OME model also has been used to calculate the relative contribution from U.S. and Canadian SO_2 emission sources to the sulfur concentrations and wet deposition over eastern North America.

- ENAMAP-1 Model

SRI International has developed a trajectory-type regional air quality simulation model (Bhumralkar et al., 1980). This model calculates monthly and annual average concentrations and dry and wet depositions of SO_2 and SO_4. The basic element of the ENAMAP-1 model is the emission of puffs of SO_2 at equal time intervals from all source areas. The puffs are assumed to be well mixed in the horizontal and vertical and to be transported by the mixed layer wind field.

The wind field is determined by objective analysis of available upper-air observations approximately 1500 m above mean sea level. Removal and transformation of the pollutant mass is treated linearly.

SO_2 emissions from the SURE program were used in ENAMAP-1 model simulations. The months of January, April, August, and October 1977 were chosen for model evaluation.

- ASTRAP Model

The Argonne National Laboratory has developed the Advanced Statistical Trajectory Regional Air Pollution Model (ASTRAP) under the MAP3S Program for simulating regional sulfur concentrations and depositions on a monthly and annual basis (Shannon, 1980).

The ASTRAP model takes a statistical approach to long-term regional modeling rather than a day-by-day simulation technique. The ASTRAP model is based on the assumption that for long-period averages, i.e., one month or longer, horizontal and vertical dispersion processes can be separated.

The long term horizontal dispersion of individual puffs is represented by dispersion statistics. Vertical dispersion is simulated by numerically integrating the standard one-dimensional diffusion equation to a height of 2100 m.

The transformation and dry deposition processes are linearly parameterized. The wet deposition is a one-half power relationship of precipitation rate. In the ASTRAP Model, seasonal and daily variations in all parameters are taken into account. A wind field is developed from National Weather Service (NWS) data at 1000 meters in the winter and 1800 meters in the summer.

Preliminary model runs have been made in the eastern United States and Canada using 1974 and 1975 meteorological data. The emission inventory (MAP3S) consisted of both point and area sources emissions in the eastern United States and Canada. The model results were then compared with measurements from the SURE data network for 1977 and 1978.

- RCDM Model

The Regional Climatological Dispersion Model (RCDM) of Teknekron Research, Inc., (TRI) is an application of the basic model developed by Fay and Rosenzweig (1980). Analytical solutions to the coupled diffusion equations for sulfur dioxide and sulfate concentrations are found through the use of simplifying assumptions. The horizontal eddy diffusivity and conversion and removal rates are uniform in space.

The TRI formulation of RCDM attempted to apply temporal and spatial averaging of the wind data sufficient to eliminate most of the detailed fluctuations while preserving the mean transport field that results from a large number of trajectories. The compromise utilized was to create a seasonal and annual resultant wind vector for each emission cell (state, province or subunit thereof) by averaging available upper air wind data for the eastern U.S. and southeastern Canada (Niemann, et al., 1980).

The conversion and removal parameters used in the RCDM are the same as those used by Fay and Rosenzweig from the literature with an annual mixing height of 1000 meters. The RCDM uses a simple deposition velocity technique to calculate dry and wet deposition of sulfur dioxide, sulfate and total sulfur. The RCDM has been evaluated against historical ambient data and current sulfur dioxide and ambient sulfate and wet sulfur deposition data.

Since complex atmospheric processes are simplified by parameterization, it is useful to examine the values used in transport and chemical transformation calculations. Table III-3 describes the fundamental variables and their parameterized values as well as the major weakness of each model.

As noted by Young and Niemann (1981), a comparison of the five models provides the following analysis:

- SO_2 to SO_4 transformation rate is generally 1% per hour, i.e., linear SO_x transformation, with some diurnal and seasonal variability.
- SO_2 and SO_4 dry deposition velocities vary by a factor of 2-10.
- Parameterization of wet removal shows the greatest variability. Again, a linear SO_x transformation is assumed.
- Wind data varies from long-term statistical to objectively analyzed fields on a variety of grid sizes.

III-2 Transfer Matrix

The primary derivative of all long-range transport models is the possible establishment of source-receptor relationships. The composite results of the five models discussed in Section III-1 were used by the Atmospheric Modeling Working Group 2 to develop a simplified matrix transfer technique for predicting the impact of one particular region on another.

The matrix transfer technique may be expressed by the simple formula

$$D_j - f_{ij} Q_i$$

where D_j is the deposition (or concentration) at the receptor "j"; Q_i is the strength of source "i"; and F_{ij} is a transfer constant relating the two variables.

The Sulfate Regional Experiment (SURE) grids were chosen by the United States to analyze the impact of one region on another. These 80 x 80 km grids were aggregated into 60 larger areas to represent state and provincial boundaries. Canadian researchers have outlined 11 basic regions based on a polar stereographic 127 km x 127 km grid. Figure III-1 illustrates the location of both grid systems.

Table III-3 shows the composite transfer matrix used to compute the impact on annual sulfur wet deposition from a change in unit emissions in a particular region. The standard deviation for each element of the wet sulfur deposition matrix is shown in Table III-4. Similar tables for ambient sulfur dioxide concentrations, ambient sulfate concentrations, dry deposition of sulfur and total deposition of sulfur have been constructed using the Canadian models (Memorandum of Intent on Transboundary Air Pollution, February 1981). The transfer matrix of annual sulfate concentration ($\mu g\ m^{-3}$) per unit emission ($Tg\ S\ yr^{-1}$) as computed by the MOE and AES models is shown in Table III-5.

III-3 Emission Inventory

Use of the transfer matrix technique obviously requires a detailed emission inventory for each region or grid square. The MAP3S Emission Inventory was used to obtain estimates of SO_2 emissions for each state or region which could then be used in conjunction with the transfer matrix to calculate sulfate concentration or sulfur wet deposition for various receptor areas. The results of the summation of the MAP3S inventory for the United States and Canadian sources are shown in Tables V-6 and V-7, respectively. The values for total SO_2 emissions in Table V-6 were obtained from Table D.1.2, Memorandum of Intent on Transboundary Air Pollution, Interim Report, 1981. Stationary or point sources were defined as those having the potential of emitting at least 100 tons (90.7 metric tonnes) per day of any of the five primary criteria pollutants of particulates, sulfur dioxide, nitrogen oxide, hydrocarbons, and carbon monoxide (Clark, 1980).

It should be noted that a considerable amount of variation can be found in published emission data. Tables III-8 and III-9 show two separate analyses of emissions by state, while Table III-10 provides an estimate of point source emissions of the five criteria pollutants per state.

Variations in emission may have a pronounced effect on calculations for a particular region.

In summary, parameters and data bases may vary greatly between various transport models. A weakness inherent in all models is the assumption of linearity between increased SO_2 input and the resultant deposition (or concentration). This simplification says that ambient concentrations and deposition will increase proportionally as SO_2 emissions increase. In reality atmospheric processes do not show this linearity.

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Table III-1

THE FIVE SELECTED MODELS

Overview:

Country	Name of Organization	Model Acronym	Type of Model	Variation
Canada	Atmospheric Environ. Service	AES-LRT	Lagrangian	Day-by-Day
Canada	Ontario Ministry of Environment	OME-LRT	Lagrangian	Statistical
U.S.	Argonne National Laboratories	ASTRAP	Lagrangian	Statistical
U.S.	SRI International	ENAMAP	Lagrangian	Day-by-Day
U.S.	University of Illinois	RCDM-2	Eulerian	Analytical

Table III-2

Comparison of the Five Basic Models Used for Development of Source Receptor Relationships

Organization and Acronym	Type and Variation	SO_2 Transformation Rate (%/hour)	SO_2 Dry Deposition Velocity (cm/s)	SO_4 Dry Deposition Velocity (cm/s)	Wet Removal Processes	Wind Data	Mixing Depth (m)	Major Weakness
Argonne Nat. Lab ASTRAP	Lagrangian Statistical	3.0-0.48 (diurnal and seasonal variations)	0.4-0.25 (summer-winter)	0.4-0.25 (summer-winter)	Precipitation Rate ($SO_2<SO_4$)	Gridded	up to 2100 @ 10 levels	Not current meteorology
SRI Intl. ENAMAP-1	Lagrangian Daily	1.0	1.0	0.2	Precipitation Rate ($SO_2 = 4xSO_4$)	Gridded (layer avg.)	1150 winter 1300 spring 1450 summer	Large SO_2 wet removal
University of Illinois RCDM-2	Eulerian Analytical	(3 day residence time used)	0.83 (dry & wet combined)	1.63 (dry & wet combined)	Depletion time scales 1½-2 days ($SO_2 = SO_4$)	Multiple point resultant vectors	1000	Wet and dry removal lumped together
Atmospheric Environ. Service AES-LRT	Lagrangian Daily	1.0	0.5	0.1	Scavenging Ratios ($SO_4 = 30xSO_2$)	Gridded (objective analysis)	Climatalogical by month (mean = 1200)	Receptor oriented
Ontario Ministry of Environment OME-LRT	Lagrangian Statistical	1.0	0.5	0.05	Duration of wet and dry periods ($SO_4 = 4xSO_2$)	Single point mean and variance	1000	Low resolution of meteorological inputs

Table III-3

Preliminary Best Estimate Mean Transfer Matrix for
Annual Wet Sulfur Deposition $kg \cdot ha^{-1} yr^{-1}$ per unit emission $Tg \cdot \underline{\underline{S}}\ yr^{-1}$

Source Region	Receptor Area 1 B. Waters	 2 Alg.	 3 Musk	 4 Que.	 5 SN-SC	 6 VT-NH	 7 Adir.	 8 Penn.	 9 Smokies
Michigan -- 1	0.37	2.06	2.16	0.93	0.36	0.39	0.86	1.09	0.15
Illinois-Indiana -- 2	0.23	0.81	0.86	0.41	0.18	0.30	0.45	0.90	0.62
Ohio -- 3	0.08	0.42	1.34	0.59	0.34	0.65	1.01	2.94	0.39
Pennsylvania -- 4	0.03	0.21	0.87	0.61	0.58	1.12	1.67	6.55	0.13
New York to Maine -- 5	0.02	0.11	0.45	0.67	2.14	2.02	1.98	0.49	0.04
Kentucky-Tennessee -- 6	0.08	0.22	0.45	0.19	0.12	0.20	0.34	1.08	3.43
West Virginia to North Carolina -- 7	0.04	0.16	0.50	0.35	0.32	0.57	0.79	3.23	0.70
Rest of Eastern US -- 8	1.10	0.59	0.32	0.17	0.09	0.13	0.18	0.44	1.24
Ontario -- 9	0.11	1.75	5.52	2.25	0.68	1.19	1.68	0.65	0.04
Quebec -- 10	0.02	0.21	0.52	1.66	1.48	2.45	1.09	0.12	0.01
Atlantic Provinces -- 11	0.00	0.01	0.04	0.27	5.23	0.94	0.32	0.03	0.00

Source: Paper No. P-2-38: AN INITIAL INTERCOMPARISON OF THE SOURCE--RECEPTOR MATRICES FOR REGIONAL MODELS OF US-CANADA TRANSBOUNDARY AIR POLLUTION. Brand L. Neimann, Acid Rain Assessment Team, US Environmental Protection Agency, Washington, DC and Edward Pechan, Environmental Consultant, Washington, DC.

Table III-4

Preliminary "Best Estimate" Standard Deviation Transfer Matrix for Annual Wet Sulfur Deposition (kg. ha^{-1} yr^{-1}) per unit emission (Tg.S.yr^{-1})

Source Region Receptor Area	1 B.Waters	2 Alg.	3 Musk.	4 Que.	5 S. N.Sc.	6 Vt. NH.	7 Adir.	8 Penn.	9 Smokies
1 Michigan	0.45	1.39	0.87	0.68	0.13	0.23	0.44	0.66	0.10
2 Illinois-Indiana	0.32	0.59	0.61	0.35	0.14	0.21	0.33	0.53	0.22
3 Ohio	0.12	0.37	0.93	0.53	[illegible]	0.44	0.67	1.46	0.29
4 Pennsylvania	0.04	0.15	0.67	0.50	0.48	0.82	1.13	2.68	0.18
5 New York to Maine	0.02	0.08	0.40	0.54	0.72	1.06	1.03	0.31	0.05
6 Kentucky-Tennessee	0.12	0.19	0.35	0.19	0.09	0.14	0.24	0.75	1.10
7 West Virginia to North Carolina	0.06	0.18	0.43	0.29	0.22	0.40	0.57	1.54	0.55
8 Rest of Eastern US	0.94	0.21	0.12	0.13	0.06	0.08	0.11	0.09	0.84
9 Ontario	0.11	0.85	4.32	1.62	0.36	0.64	0.77	0.41	0.06
10 Quebec	0.02	0.19	0.41	1.16	0.65	0.71	0.75	0.07	0.01
11 Atlantic Provinces	0.01	0.01	0.04	0.25	6.83	1.02	0.52	0.03	0.01

Table III-5

Transfer Matrix of:

Annual Sulfate Concentration (ug/m^{-3}) per unit emission (TgS.yr^{-1})

		Receptor Areas		
Source Regions	Models	Vt. NH. (6)	Adir. (7)	Penn. (8)
1 Mich.	MOE	0.46	0.61	0.86
	AES	0.80	0.94	1.5
2 Ill. Ind.	MOE	0.25	0.31	0.57
	AES	0.22	0.34	0.72
3 Ohio	MOE	0.30	0.38	0.88
	AES	0.41	0.63	2.3
4 Penn.	MOE	0.33	0.41	1.1
	AES	0.50	0.91	2.5
5 N. York to Maine	MOE	0.35	0.38	0.19
	AES	0.55	0.70	0.18
6 Kent. Tenn.	MOE	0.17	0.20	0.38
	AES	0.06	0.11	0.56
7 W.Virg. to N.C.	MOE	0.22	0.26	0.42
	AES	0.17	0.27	0.90
8• Rest of (USA) Fld to Mo. to Minn.	MOE	0.22	0.26	0.35
	AES	0.08	0.13	0.29
9 Ontario	MOE	0.69	0.69	0.34
	AES	1.4	1.9	1.0
10 Quebec	MOE	.75	0.34	0.14
	AES	1.9	1.4	0.17
11 Atlantic Provinces	MOE	0.13	0.10	0.06
	AES	0.04	0.04	0

Table III-6

United States Emission Inventory Comparison

State	MAP3S Stationary SO$_2$ Emissions (10^6 kg yr^{-1})	Total SO$_2$ Emissions (10^6 kg yr^{-1})	Difference (Total-MAP3S)
New York	415.0	1041.1	626.1
Pennsylvania	1589.8	1900.0	310.2
Virginia	371.2	359.9	-11.3
Illinois	2223.3	1747.2	-476.1
Ohio	3213.5	3115.3	-98.2
Indiana	1657.8	1848.2	190.4
New Jersey	289.9	323.7	33.8
Kentucky	1446.5	1330.0	-116.5
Massachusetts	239.1	402.2	163.1
Tennessee	1069.3	1162.8	93.5
Connecticut	111.3	112.0	0.7
Delaware	104.7	188.2	83.5
Washington, DC	7.6	-	-7.6
Maine	107.9	66.0	-41.9
Maryland	263.8	357.3	93.5
Michigan	1114.8	1117.8	3.0
New Hampshire	94.3	67.8	-26.5
North Carolina	585.5	562.3	-23.2
South Carolina	148.7	288.6	139.9
Rhode Island	10.9	19.7	8.8
Vermont	0.2	-	-
West Virginia	1068.7	1049.5	-19.2
Alabama	850.6	762.1	-88.5
Arkansas	123.6	121.6	-2.0
Florida	943.6	685.9	-257.7
Georgia	678.8	707.0	28.2
Iowa	433.6	385.0	-48.6
Louisiana	259.9	359.0	99.1
Minnesota	276.4	379.0	102.6
Mississippi	138.4	264.3	125.9
Missouri	1244.2	1307.7	63.5
		Net Difference	959.8

Table III-7

Canadian Stationary Emissions as Determined by
MAP3S Emission Inventory
(industrial and utility emissions)

Region	Stationary SO_2 Emissions (10^6 kg yr^{-1})
9	2043.2
10	853.9
11	8.9

Table III-8

	State (by rank)	SO_x emissions (10^6 tons)	% U.S.	Major source(s) - % of state
1.	Ohio	3.26	10.3	EG/BC - 82
2.	Pennsylvania	2.5	7.9	EG/BC - 56, IF/PG - 10 IF/BC - 8, PM - 11
3.	Indiana	1.89	6.0	EG/BC - 79
		Subtotal	24.2	
4.	Illinois	1.71	5.4	EG/BC - 78
5.	Kentucky	1.63	5.2	EG/BC - 94
6.	Texas	1.54	4.9	CM - 25, IF - 17 PM - 14, EG/L - 13 PI - 11
7.	Missouri	1.5	4.8	EG/BC - 83
8.	Tennessee	1.28	4.1	EG/BC - 85
9.	Arizona	1.24	3.9	PM - 88
		Subtotal	52.5	
10.	West Virginia	1.23	3.9	EG/BC - 85
11.	Michigan	1.22	3.9	EG/BC - 72, IF/BC - 8.5
12.	Alabama	1.04	3.3	EG/BC - 75 PI - 3, T - 2.5
13.	New York	1.02	3.2	EG/BC - 25, EG/RO - 25 CIF/RO - 13, IF/RO - 11 IF/BC - 9
14.	Florida	0.989	3.1	EG/RO - 39, EG/BC - 37 CM - 6.5
15.	Georgia	0.7	2.2	EG/BC - 73, EG/RO - 9
16.	California	0.675	2.1	PI - 19, EG/RO - 18 T - 16, IF/RO - 16 EG/DO - 9, CM - 7
17.	Wisconsin	0.666	2.1	EG/BC - 70, IF/BC - 15
18.	North Carolina	0.618	2.0	EG/BC - 68, IF/RO - 12
19.	New Mexico	0.576	1.8	PM - 43, EG/BC - 25 PI - 16
		Total	80.1	

NOTE: EG = Electric generation
IF = Industrial fuel use
CIF = Commercial/institutional fuel use
BC = Bituminous coal
RO = Residual oil
DO = Distillate oil
PG = Process gas
L = Lignite
PI = Petroleum industry
PM = Primary metals
CM = Chemical manufacturing
T = Transportation

Source: Table 2-6-National Distribution of 1977 SO_x Emissions, Acid Rain Information Book, Draft Final Report, December 1980, prepared by GCA Corp., Bedford, MA, under Contract No. AC02-79EV10273-1 for U.S. Dept. of Energy, Assistant Secretary for Environment, Office of Environmental Assessments, Washington, DC, DOE/EV/10273-1.

Table III-9

State	SO_2	NO_x
Alabama	762.1	473.0
Arkansas	121.6	217.9
Connecticut	112.0	183.0
Delaware	188.2	70.6
District of Columbia	17.6	33.5
Florida	685.9	777.4
Georgia	707.0	548.8
Illinois	1747.2	1129.9
Indiana	1848.2	600.6
Iowa	385.0	321.0
Kentucky	1330.0	563.0
Louisiana	359.0	1593.7
Maine	66.0	76.7
Maryland	357.3	313.9
Massachusetts	402.2	364.3
Michigan	1117.8	843.1
Minnesota	379.0	399.6
Mississippi	264.3	272.8
Missouri	1307.7	563.0
New Hampshire	67.8	66.9
New Jersey	323.7	494.4
New York	1041.1	908.9
North Carolina	562.3	591.0
Ohio	3115.3	1277.1
Pennsylvania	1900.0	1120.7
Rhode Island	19.7	42.4
South Carolina	288.6	300.2
Tennessee	1162.8	592.9
Texas	1244.8	3309.5
Vermont	-	-
Virginia	359.9	435.2
West Virginia	1049.5	462.4
Wisconsin	663.6	473.2
TOTAL	23957.2	19420.6
	or 21.73 million tonnes	17.62 million tonnes

Source: Table D.1.2-1978 SO_2 and NO_x Emissions by State (10^3 tons), United States-Canada Memorandum of Intent on Transboundary Air Pollution, Interim Report, February 1981, Work Group 3B, Engineering, Costs and Emissions, Interim Report, January 15, 1981.

Table III-10

	No. of Plants	No. of Points	Emissions (10^3 tonnes/yr)				
			Particles	SO_2	NO_x	HC	CO
Alabama	395	925	122	214	68.6	71.7	57.3
Connecticut	153	478	22.5	111	39.8	15.3	7.6
Delaware	137	603	21.6	169	22.0	18.1	8.7
District of Columbia	31	90	2.1	7.9	4.7	.7	3.3
Florida	1232	3041	160	993	478	39.0	79.2
Georgia	303	1271	74.6	538	174	9.0	108
Illinois	699	2808	764	2290	1390	410	458
Indiana	1501	3564	408	1820	1190	141	1590
Kentucky	1802	5850	564	1500	321	189	68.3
Maine	657	1591	34.7	108	29.0	48.2	54.4
Maryland	214	1418	59.3	470	136	46.2	106
Massachusetts	1098	1917	52.8	239	75.5	79.1	32.4
Michigan	1048	2452	300	1490	400	211	492
Mississippi	1699	3585	142	125	69.5	42.8	205
New Hampshire	301	546	10.6	94.3	35.3	41.1	21.6
New Jersey	663	4034	54.7	311	192	254	190
New York	5844	2852	229	422	229	66.4	68.0
North Carolina	2056	4607	194	433	184	50.6	124
Ohio	1243	4888	867	3180	573	180	2420
Pennsylvania	1566	4675	758	2700	598	113	276
Rhode Island	262	602	2.2	10.9	5.6	17.3	2.6
South Carolina	524	1365	107	268	128	41.9	122
Tennessee	2203	6558	311	1150	277	97.1	180
Vermont	185	681	.7	.7	.3	1.7	.2
Virginia	664	1804	348	419	160	111	195
West Virginia	313	1004	167	1070	456	10.8	2150
Wisconsin	309	1009	227	568	206	168	69.1

Source: Table 4.4-MAP3S Point Source Emissions Inventory, The Multistate Atmospheric Power Production Pollution Study-MAP3S, Progress Report for FY 1977 and FY 1978, sponsored by U.S. Dept. of Energy, Assistant Secretary for Environment, Office of Health and Environmental Research, July 1979, DOE/EV-0040.

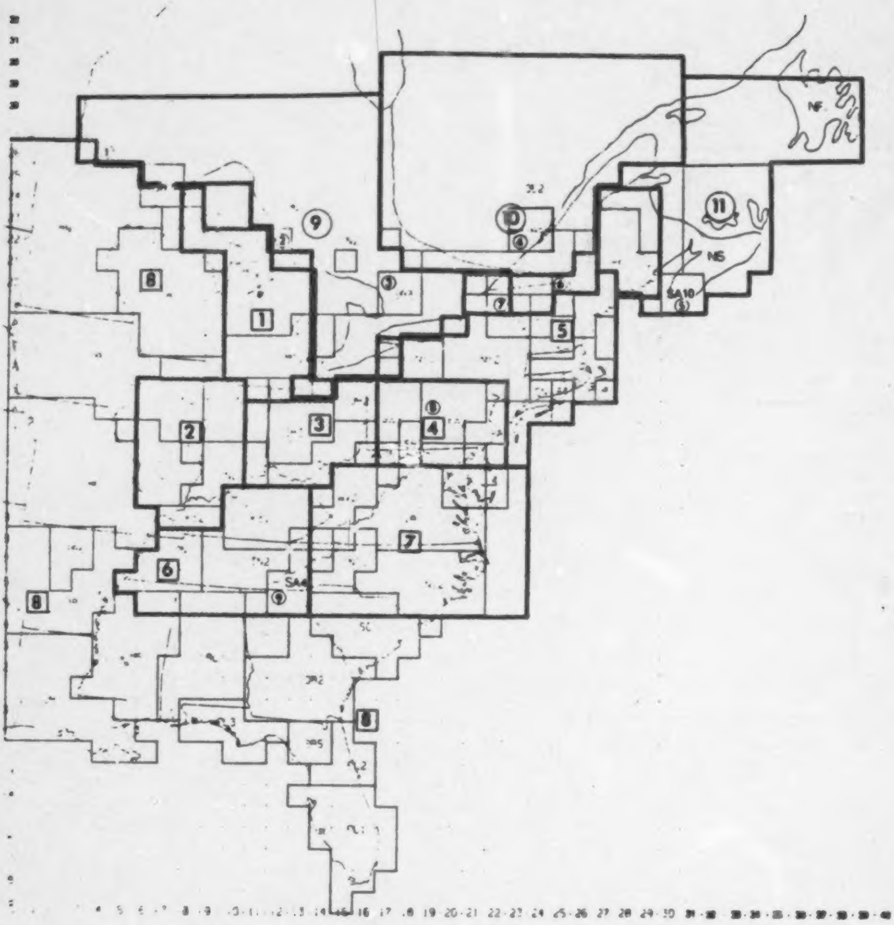

Figure III-1. Map of eastern North America showing the two sets of geographical regions used in Work Group 2 modeling. Light and heavy (solid in Canada; slashed in U.S.) lines outline regions used by U.S. and Canadian models, respectively. U.S. aggregate SURE grid regions are identified by 2 or 3 character alpha-numeric labels (light), with sensitive areas having 'SA' as the first two characters. Canadian-model source regions are identified by large numbers, in boxes in the U.S. and in circles in Canada, and sensitive areas are identified by small numbers in circles.

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February 3, 1982

Dear Congressman Scheuer,

I am pleased to enclose an analysis of the two elements of Dr. Volker Mohnen's hypothesis which you asked us to examine. Our study addresses the points made in testimony at the Lake Placid hearings on September 18, 1981.

As Director of a highly respected Atmospheric Sciences Research Center, Dr. Mohnen is well-known internationally although more for his work on cloud physics and weather modification. Concerning acid rain, he presents some new concepts which have not yet been fully peer reviewed and published in the open scientific literature and, therefore, are still very much the views of one scientist.

The testimony has been reviewed independently by several Canadian scientists. These reviews raise many questions about Dr. Mohnen's testimony, his analysis of data from Whiteface Mountain and especially the validity of the "superbowl" hypothesis he is proposing. These reviews have been consolidated into the attached document in a way that analyzes the two specific issues raised in your letter of 22 September 1981.

Clearly, this is a complex issue and there is no simple answer. We do hope, however, that the attached analysis will give some insight into how our leading scientists view the "saturation" hypothesis.

With kindest personal regards,

Yours sincerely,

George Rejhon
Counsellor (Environment)

The Honourable
James H. Scheuer
United States House of Representatives

ANALYSIS OF THE TWO ISSUES RAISED BY CONGRESSMAN SCHEUER AS A RESULT OF DR. MOHNEN'S TESTIMONY AT THE LAKE PLACID HEARINGS ON 18 SEPTEMBER 1981

1. Introduction

This analysis is based on reviews and comments by scientists with the Air Resources Branch of the Ontario Ministry of the Environment and the Air Quality and Inter-Environmental Research Branch, Atmospheric Environment Service, Environment Canada. These detailed technical reviews raise questions about many aspects of Dr. Mohnen's data analysis and interpretation but this document focuses on the two major issues raised by Congressman Scheuer in as simple and as direct a fashion as possible.

Since the first issue is directly related to the "superbowl" hypothesis proposed by Dr. Mohnen it is first necessary to provide comments on this hypothesis.

2. The "Superbowl" Hypothesis

From a detailed analysis of data from two observing sites (Whiteface Mt. and Champaign-Urbana, Illinois) plus some additional data from six other sites Dr. Mohnen concludes that the almost uniform "normalized" wet deposition (1) pattern over the mid-west SO_2 emission source region (2) indicates the existence of a saturated superbowl of pollution.

Dr. Mohnen claims there is no gradient in the wet sulfate deposition concentration by comparing Champaign, Illinois data with Ithaca and Whiteface Mountain, New York. A very significant gradient would only occur if the winds were only blowing in a west to east direction, a fact that he should know is not true. Winds with varying frequency occur in all directions. SO_2 and sulfates will be transported into Illinois with easterly winds and into New York during southwest wind conditions.

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(1) Dr. Mohnen uses the term deposition not in the usual sense but as a precipitation-weighted mean concentration in the precipitation.

(2) The source region referred to by Dr. Mohnen is Ohio plus the mid-west states.

He chose an Illinois location which was nearer to the source area being considered than the locations in New York State. There are in fact large coal burning power plants in Southern Illinois, south and southwest of the Champaign site. These are the Baldwin (outside East St. Louis), Coffeen, Kinkead and Joppa Steam power plants which in total emit approximately 640 thousand tons of SO_2 per annum. These sources are 120 to 300 km from Champaign. There are no large sources as near to Whiteface Mountain that could distort the data similarly. It is thus not surprising that the site showed a high % of sulfates in precipitation during events with trajectories in the directions similar to that at Whiteface Mountain.

Furthermore, the two sites are much different in nature including elevation, precipitation amounts (3 times as much at Whiteface Mountain), type of precipitation and seclusion from local sources. These differences may be as important, as the fact that one is well to the east of the source area and one is supposedly west of it. If Dr. Mohnen had selected locations as far to the west of the source area as the sites, Ithaca and Whiteface Mountain are to the east, he would have found the gradient that he said does not exist.

The highest deposition will of course be over the source area since the average wind speed, will only transport pollution a distance of some 200 miles in 24 hours. Deposition does take place during this transport but a large proportion is ventilated out of the area as indicated by the measured levels in New York and Ontario, as well as by the visual evidence from satellite pictures and aircraft observations.

It should be pointed out that Mohnen's procedure of "normalizing" the deposition data by total precipitation amount is apparently simply equivalent to calculating the average concentration during the period in question. If his conclusions are compared with the results of other workers, they are found to be questionable. For example, Pack (Science, 208, 1142 (1980)) has done a similar analysis on regional concentrations, using approximately one year's data from MAP3S (August 1978 - June 1979), but supplemented with data from the SURE network. Pack's more extensive database shows fairly clearly the influence of the major sources in the Midwest on precipitation sulfate and nitrate concentrations. Pack concludes that "...There is a definite north-south gradient, with the SO_4 concentrations at the southern edge of the data lower by 30 to 50 percent than the maximum concentrations...". Similarly, a recently-published map of SO_4 concentrations from the NADP and CANSAP networks during the period March 1979 - March 1980 (Project NC-141-NADP Annual Report, January 1 - December 31, 1980) shows the influence of major source areas on sulfates in precipitation.

In addition, neither the data nor the analyses presented by Dr. Mohnen give a clear physical/chemical description of what a "superbowl" is nor a full scientific demonstration of its existence. It appears that the concept of a "superbowl" as used by Dr. Mohnen describes a pattern (of observed deposition) (1) rather than a process and can be misleading in that it conjures up the notion of a large basin or airshed filled with a pollution mix. Thus Dr. Mohnen's concept of a superbowl must be considered as still speculative at this time. Further detailed analyses of all data available from aircraft and other stations (not just the limited set considered by Dr. Mohnen) may give credence to some of his ideas, or on the other hand many completely invalidate his concept. It is, therefore, premature for Dr. Mohnen to use this unproven hypothesis to make some of the strong statements such as "The main result is that a source-receptor relationship between high emission density areas and wet deposition of pollution-related ions cannot be established at this time" and to then later say "the concept of a superbowl can be used in the absence of a source-receptor relationship (emission - wet deposition relationship) to explain the relatively uniform west-east wet deposition (1) distribution pattern for sulphate".

There are certain basic facts in our current understanding of the emissions and fate of atmospheric sulfur compounds which are accepted by the scientific community both in North America and Europe, and probably would not be denied by Dr. Mohnen himself. These are:

(1) The anthropogenic contribution dominates the sulfur emissions in E. North America, being about 10 times greater than natural emissions. Of the anthropogenic emission, a very large proportion (almost one-half) are concentrated in the Midwestern states, and are largely due to utilities (almost 80% of the total).

(2) The residence time of sulfur compounds in the atmosphere is typically one to five days, with sulfur dioxide being converted at rates of up to a few percent per hour to sulfates. Thus, long-range transport and chemical transformation downwind of the source areas occurs throughout the year.

Dr. Mohnen seems to ignore the massive upwind source of anthropogenic SO_2 emissions, and talks in terms of a rather vague reservioir of atmospheric sulfur dioxide, which is acted on by chemistry and meteorology to produce sulfates. Granting the fact that chemistry and meteorology are dominant factors, one wants to ask, "Where did all the sulfur come from in the first place?".

Other scientists from the New York State Department of Health (Parekh and Husain, 1981)* at a meeting of American Chemical Society in August 1981 (and to be fair this was not available to Dr. Mohnen at the time he prepared his testimony) presented some very strong evidence regarding the impact of mid-west sources on the air quality (sulphate concentrations) at Whiteface Mountain. They analysed the data from the same location as Dr. Mohnen but, by looking at what is in the air rather than what is in the precipitation, giving a quite different impression regarding source-receptor relationships. The two following statements in this analysis are of particular interest.

a) "By comparing the distribution profile (of sulphate by wind sector) with the point emission profile it becomes evident that the strong sources have long-range directional impact on the downwind environment."

b) "From the (directional) distribution pattern of sulphate concentration we further conclude that about 85% of the long-range transported sulphate component is brought at the site (Whiteface Mt.) by tropical maritime air masses from the S — SW while continental air from N — NW contribute only about 13%."

These two statements directly contradict Dr. Mohnen's assessment that "the available evidence still does not reliably demonstrate that those sulphate levels (at Whiteface Mt.) can be related to levels of SO_2 emission sources from the mid-west."

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*Parekh, P.P. and L. Husain, 1981: "Temporal Variation and Spatial Influx of Particulate in Ambient Air at Whiteface Mountain, New York." American Chemical Society, Division of Environmental Chemistry, 182nd National Meeting, New York, N.Y. Vol. 21, No.2.

The amount of material found in the air is more closely related to total depostion (both wet and dry) than to wet-only deposition. It has been found that the dry component can form a considerable portion of the total deposition. This is especially true for the drier areas close to large emission sources, since wet deposition is strongly linked to the amount of rainfall. Mohnen's theory is based on "normalized" wet deposition only and not on total deposition.

One does not have to invoke the "superbowl" concept to explain the deposition (1) patterns over and immediatley east of the major source region. In fact, the current generation of long-range transport models, by taking into account (admittedly in a simplified fashion) many of the chemical transformation and precipitation scavenging processes not considered by Dr. Mohnen in his analysis, do predict the concentration fields and deposition patterns similar to what Dr. Mohnen calls a "superbowl". And furthermore, at any point within the high deposition region (as we prefer to call it) the models can relate concentrations and deposition back to the emission sources at least in a qualitative or semi-quantitative way. Through the use of these models it is possible to establish source-related concentration and deposition patterns for each short time period (such as 6 hr or one day) which when averaged over longer time periods (such as a month or a year) gives a relatively uniform concentration field similar to that discussed by Dr. Mohnen. Therefore, the presence of this uniform field should not be construed as evidence for the lack of any source-receptor relationship. With further refinement of the models (now being pursued vigourously by three Canadian and five U.S. modellers under the Memorandum of Intent activities) this relationship should rapidly become more quantitative, more reliable and more generally accepted as a useful tool for considering various emissions cut-back strategies.

3. Response to First Issue

The assessment by Dr. Mohnen that "a moderate reduction of SO_2 emissions would not in all likelihood lead to a reduction in the acidity of rain over a large saturated area" is of course a direct outcome of applying his superbowl concept. Acceptance of this assessment is, therefore, contingent on accepting the validity of his hypothesis. The comments in 2 above raise several points which throw some doubt on the validity of, or even the need to invoke, the hypothesis.

The idea of "saturation" is not new but in reality it is a very complex phenomenon which is difficult to document by observations. In principle it is possible that under certain conditions the conversion of SO_2 to SO_4 in clouds could be limited by the availability of some catalyst or oxidizer. Exhaustion of the catalyst could thus lead to no further SO_4 in the precipitation and no further decrease in rainfall pH. The distinction between the concept of saturation as occurring "on the average" over a large area at all times, and as occurring only under certain chemical and meteorological conditions (i.e., at particular times and places) is important to make. The latter is more likely to occur in view of the large temporal and spatial variability of the chemical and meteorological environment, so that it is not realistic to think of a permanent, extensive saturated region all the time. The remainder of the time would then be non-saturated and any decrease in SO_2 emissions would lead to a decrease in wet deposition of SO_4. Thus long-term average deposition would also decrease in response to decreased emissions.

4. Response to the Second Issue

It is generally agreed that both processes of wet and dry deposition are important in eastern North America and the best estimates, averaging over the whole region of interest, indicate that the two are roughly equal. However, it is also well known that close to a large emission source-area dry deposition exceeds wet deposition on average. This is because the rate of dry deposition of SO_2 or sulphates is directly related to the concentration of these pollutants in the air. A reduction in SO_2 emissions would have an immediate effect in reducing air concentrations, and hence the rate of dry deposition at all downwind distances and especially close to the source.

Dr. Mohnen does not define or document his region of saturation, but if one accepts for a moment the superbowl saturation hypotehsis regarding wet deposition then there must be an eastward limit to this region. Thus, while Mohnen suggests that there would be no reduction in wet deposition in the Adirondacks due to a mid-west emission reduction, there would almost certainly be a substantial decrease in wet deposition further downwind i.e., over New England and much of eastern Canada. At the same time Mohnen's hypothesized saturated region would decrease in area. Therefore, a moderate decrease in SO_2 emissions (say 25%) would give a reduction in dry deposition over the northeast of about 25% and a reduction in wet deposition of between 0 and 25% depending on whether Mohnen's saturation hypothesis is operative or not and whether its limit is close to or distant from the main source region.

Thus, an emissions reduction of 25% would give a total deposition reduction of at least 12.5% (even fully accepting the superbowl concept) in the near source region but more likely closer to 25%. Further downwind the reduction would be close to 25% in any case. There is no observational evidence to indicate that there is any significant accumulation of sulphur in the atmosphere at the present time. Thus, on a simple "what goes up must come down" budget basis, any reduction in sulphur emissions would automatically lead to a corresponding reduction in sulphur deposition in the total affected downwind region. Many of the long-term ecological effects are due to total deposition and whether it is wet or dry is irrelevant. Thus, even though the reduction in deposition may not necessarily show a one-to-one equivalency with reductions in emissions it would none-the-less be significant and beneficial.

5. Final Comment

Dr. Mohnen's testimony has four major shortcomings.

1) it invokes a new hypothesis to explain a wet deposition (1) pattern with only weak and questionable scientific documentation of its validity. He then goes on to use the hypothesis to make several strong statements regarding saturation and its implication for the effects of emissions reductions in a way that is more one scientists's opinion rather than being scientifically defensible.

2) it ignores half the problem (dry deposition).

3) it cannot be used to produce the sort of simulations that atmospheric models can, and these simulations are now giving us much more insight into the processes and the resultant downwind regional effects on concentration and deposition due to emissions sources.

4) these ideas tend to be contradicted by experimental data.

Because of these shortcomings, it is difficult to accept Dr. Mohnen's assessment at this time or until such time as much stronger scientific evidence is brought forward to indicate otherwise.

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Mr. **Scheuer.** Dr. Mohnen, if I am concerned about the Eastern United States, particularly about New England, the Middle Atlantic States and Canada, and we seem to feel that much of the pollution comes from the Ohio River Basin, and you tell us there is no linear relationship, on a cost-benefit basis what do you suggest that we mandate the Ohio River Basin do to give us an appreciable reduction in acid rain in this portion of the United States? What national policy should we produce to ameliorate acid rain for the Adirondacks, for Canada, for the eastern seaboard, and the Middle Atlantic States?

Dr. **Mohnen.** Your question is well taken. Let me answer this with scientific data from Europe. The same question was asked there. One scientist, Dr. Granat—University of Stockholm—has investigated the acid rain situation in Europe, covering a period of 10 years. As you said at the beginning, they are way ahead of us.

During those 10 years, from 1965 until 1975, the sulfur dioxide emissions in Europe have increased by 40 percent. The areas that the network covered did not show any significant change in wet deposition. That led me to believe that the European area covered by the OECD network has not seen a worsening of the acid deposition with regard to sulfate during a time when the sulfur dioxide emissions have increased by 40 percent.

Turn this around. If you would ask for a 40-percent reduction, now, Europe would return back where it was in 1965, and the wet deposition within the area covered by the network will not respond. If you go beyond that region you should see dramatic improvements, however.

Mr. **Scheuer.** Would you apply that now to the United States?

Dr. **Mohnen.** For the United States it could well be that we have to reduce the emissions in the Midwest by more than 50 percent to see an improvement in wet deposition to the Adirondacks.

Mr. **Scheuer.** How much of an improvement? If you asked the Midwest utilities and manufacturing sources to decrease their polluting effects by 50 percent to get only a 2-percent improvement on the eastern seaboard and Canada on a cost-benefit basis, that would be a ridiculous investment for us to ask them to make.

Dr. **Mohnen.** I agree, and it is this question the scientific community has to answer.

Mr. **Scheuer.** My question to you is, how much of a reduction in polluting effects does it make sense for us to ask them to make in order to produce a significant reduction in acid rain in the eastern seaboard and Canada?

Dr. **Mohnen.** This is totally unknown, and it is an honest question. There is not one atmospheric scientist who would be willing to put his reputation down by answering this question. Simply because we are now recognizing the nonlinearity of the problem. I believe even my colleagues in Canada will agree with that crucial question.

Mr. **Scheuer.** We will find out tomorrow.

Dr. **Mohnen.** The problem that we are facing is, how much in reduction should the scientific community recommend to you in the absence of a good scientific date base.

My answer to this is, any kind of methods that are "cheap" should be utilized before really going into the very high cost and very high technology items such as retrofitting of existing coal plants.

I think the speaker of the New York State Assembly this morning put it quite well when he said we should minimize our emissions; we should wash coal, and we should introduce any other measures that can be imposed upon the economy and postpone the severe solution until the atmospheric scientific community can come forth with the answer—with even the rough guess that you ask for.

Mr. **Scheuer**. When you say severe solutions, I take it you mean the capital-intensive.

Dr. **Mohnen**. Yes.

The National Center for Atmospheric Research is ready and on standby to carry out research projects of that nature. I believe that NOOA and other agencies are also ready. Indeed, the lack of research money in this particular area to me is inexcusable when we have such clear questions that need to be answered within the next 3 years.

Mr. **Scheuer**. I couldn't agree with you more. This subcommittee took a trip out to Boulder in August and visited with the Director of National Center for Atmospheric Research (NCAR), Bill Hess and his colleagues, and we were very much impressed with what they were doing and the capability they have to come up with hard answers.

Dr. **Mohnen**. And the other universities they can call upon.

Mr. **Scheuer**. I will ask Congressman Carney to control the last 5 minutes of the questions and answers.

Mr. **Carney**. Thank you very much, Mr. Chairman.

When you consider a region to be a saturated atmospheric region, are you saying we can't pollute that any further?

Dr. **Mohnen**. The historical proof over the past 20 years in Europe and the trend in this country seem to indicate there is a limiting process for the transformation of sulfur dioxide into acid rain. The limiting process seems to be the ability of the clouds to convert sulfur dioxide. There is enough sulfur dioxide outside the cloud waiting to move into the cloud and to be processed into acid rain.

Yet there are substances that control this manufacturing of acids. That is where the limiting step comes in.

Mr. **Carney**. Is this research basically done on rain? How about the impact of continuing to do what we do in the Ohio Valley on the solid part of pollution that contributes to the acidity level of lakes and land?

Dr. **Mohnen**. There exists a better understanding of the mechanisms of dry deposition. The "raining down", of particles that are acidic on the forest system, on the land, is much more proportional to changes in emissions, but not quite.

Mr. **Carney**. If we cut back emissions from the Ohio Valley 50 percent right now, we are not going to enhance the acid rain part of the pollution, but we certainly would have positive effects on the dry pollutants that are deposited here in the Adirondacks?

Dr. **Mohnen**. That is to be expected.

Mr. **Carney**. And we would also protect other areas that have not reached a saturated point, although it is not a lineal equation we are dealing with. There is some clean air that if we stop doing what we are doing in the Ohio Valley today, will only reduce it 50 percent, we will protect that resource that is vital to us, although we would like to see something immediately happen here in the Adirondacks.

How about in Maine? Do we have a positive effect by stopping right now 50 percent?

Dr. MOHNEN. You understand the problem, and I agree with your answer. Where precisely to put this limit where you go of a saturated airshed is quite uncertain. It might be 50 degrees north, as the Canadians think. It might be at the edge of Maine, but obviously lack of data does not allow us to name a precise limit.

Mr. CARNEY. In conclusion, may I say you are suggesting if we cut back right now, we will have a positive effect on solid—we will have positive effects on areas that are not considered to be saturated atmospheric areas, and you in no way are saying don't do it, but you are saying be cautious that those who might oppose our doing this will come at you and say there has been no improvement in the acid rain problem in a saturated area, and we have wasted an awful lot of money and we have put an awful lot of constraints on those who are polluting the air. They are just trying to caution us of that problem.

Dr. MOHNEN. I caution the members who represent the district here.

Mr. SOLOMON. Will the gentleman yield?

Mr. CARNEY. I yield.

Mr. SOLOMON. Your blue cylinders that you have there, considering the tall one as the Ohio Valley, describe the other areas that you are talking about there.

Dr. MOHNEN. This center one represents the Adirondacks. You probably will have to go significantly down in emissions before the Adirondacks see a positive effect, but you can have an immediate effect north of 50 degrees, and probably as you exit Maine. But beyond Maine is the Atlantic Ocean with alkaline water which could care less about wet deposition.

Mr. SCHEUER. Where does this leave the Adirondacks and Canada, in terms of what we can reasonably ask the Ohio River Valley complex of polluters to do. How much of an investment would they have to make to have an appreciable effect on this Canada-United States environment around here, extending north?

Dr. MOHNEN. As my colleagues tell me, the most ideal experiment that an atmospheric scientist would need at this time to give an answer in 2 weeks, is to shut down the Ohio Valley, let us test, put it back on and we would know that answer. It is as simple as that. If we don't do this, we cannot answer this question within 14 days. It will take us at least 3 years.

Mr. GREGG. Didn't they shut it down?

Dr. MOHNEN. Sudbury/Canada was shut down and it did not make a difference on the wet deposition in New York State. It is one of the things that support my concept of the "saturated airshed."

Mr. SCHEUER. Do you suggest if we close down all the polluting sources, there might not be any statistically verifiable reductions in acid rain?

Dr. MOHNEN. Oh, no. I say if you shut down the Ohio Valley, then I am certain it will have surprising effects.

Mr. SCHEUER. Up or down?

Dr. MOHNEN. Significant improvement, if one would totally shut down the Midwest Ohio Valley, but this is not a realistic proposal.

Mr. SCHEUER. You say if we close down the Ohio River Valley, it would have significant effects on the eastern seaboard of the United States and Canada?

Dr. MOHNEN. Yes, sir.

Mr. SCHEUER. Let's get to a more realistic question: At what minimum order of magnitude of capital investments in antipolluting technology does it make sense to ask the Ohio River Valley to make in order to achieve a significant reduction in pollutants in Canada and the eastern seaboard of the United States, including this Adirondack neighborhood?

Dr. MOHNEN. A very famous physicist, Newton, once said, what goes up must come down. If that is all we are interested in, then any change in emission, somewhere on this confined spaceship of ours will result in improvements. When the question is more specific then the atmospheric scientists have a question mark.

Mr. SCHEUER. This is the key question. If we are going to ask them to spend billions of dollars in reduction of pollutants in order to reduce the fall of acid rain in the Arctic's cap or Atlantic Ocean with very little improvement in Canada and the eastern seaboard, that is not a very reasonable, cost-effective public policy to impose upon them.

You have a couple itinerant Canadians who prematurely wandered down to our precincts, and they are armed with their concern and their outrage. If you hang around with your bulletproof vest until tomorrow, you will see them en masse down here.

What would be a cost-effective approach for us to demand in terms of capital expenditures in the Ohio River Valley in order to produce a significant improvement in acid rain in Canada and in this portion of the United States?

Dr. MOHNEN. First I must qualify the answer before I will give you the answer. There is a solution to every problem: The solution is simple, straightforward and wrong. I will answer a question that you have not raised:

We need a program of several million dollars, on the order of $5 million at least, that will last 3 to 5 years, and during that time we will come up with the answers, like we did with the CIAP program. It will tell you within a certain percentage by how much you must reduce the emissions in the combined, complex Midwest Ohio Valley, eastern seaboard, Washington/Boston region, in order to have a 50 percent improvement in wet deposition.

Mr. SCHEUER. Improvement here, not in the Arctic's cap or the Atlantic Ocean?

Dr. MOHNEN. Improvement in the Adirondack Mountains.

Mr. SCHEUER. And Canada?

Dr. MOHNEN. Canada will see the improvement earlier, obviously. If you start with 10 percent emission reduction in the Midwest Ohio Valley and the eastern seacoast; you will necessarily find somewhere improvements in the wet deposition. But it will take more to move the improvement closer and closer to the source.

Mr. **Carney**. The chairman has used 30 seconds of our 5 minutes, so I yield 5 minutes to Mr. Sensenbrenner, of Wisconsin.

Mr. **Sensenbrenner**. There is a 50 percent reduction in what comes out of the Ohio Valley. What change do you think that would make in a 3-year period in the pH content of the rain here in the Adirondacks?

Dr. **Mohnen**. None. It will stay at 4.17 average annual mean, as it has for the past 3 years, and in all likelihood, that is the same pH that we see in Champaign, Ill. I think we still will be in the "saturated airshed".

Mr. **Gregg**. I have no questions.

Mr. **Solomon**. Just one quick question based on those cylinders, again. What would happen if they reduced all the smokestacks in the Ohio Valley to where they were 10 years ago? Then what would happen?

Dr. **Mohnen**. I think that the issue of tall smokestacks has been overplayed when it comes to acid rain. The amounts of SO_2, the amount of material that eventually reaches the air that we breathe up here, that amount of SO_2 still is sufficient to convert into acid rain. Simply, our problem is not that we have not enough sulfur dioxide to process. Those clouds have all the amount of sulfur dioxide that they can convert into acid.

So by changing smokestack height, you vary the concentration of sulfur dioxide that is available downwind, but if you already have enough, that doesn't matter much. You certainly cannot change the sulfur dioxide concentration by anything like 50 percent.

Mr. **Solomon**. This is the first new testimony we have heard today, because that goes counter to what we have all been told in the past. That is interesting.

Dr. **Mohnen**. It is recognized nowadays that the classical picture is in doubt and new concepts emerge from ongoing research that have not even been published—projects like OSCAR and projects like APEX, that are being conducted.

But I think the most important part is to establish a link between the atmospheric science community, working on those problems, and you, the decisionmakers, to get the not only exciting but revealing research right straight to where it counts.

Mr. **Mitchell**. You mentioned, Doctor, that in Europe they increased their sulfur pollutants by something like 40 percent over a 10-year period, and there were no more serious effects.

Dr. **Mohnen**. You are one step ahead. There were no measurable differences in wet deposition. Effects can be accumulated over years and years and years.

Mr. **Mitchell**. Aren't most of the lakes dead in Sweden, anyway, before your 10-year increase in 40 percent? Hadn't we already recommended them before we came along with this evaluation? Weren't most of the lakes dead already in Sweden?

Dr. **Mohnen**. When it comes to aquatic effects, please don't address the question to me. What I have said so far I can back up. When it comes to dead lakes in Sweden, I have to refer that question to somebody else.

Mr. **Mitchell**. The information we have had from some sources is because the scientists dillydallied for about 15 years in Europe, they never did solve the problem, and that the lakes are mostly dead in Sweden. I am just commenting on your observation. How much more can you hurt them once you have killed them?

Let me get to another point. You mentioned the environment is saturated now. If someone were to put up a thousand more coal-burning plants in the Ohio Valley, that wouldn't bother us at all?

Dr. MOHNEN. The factor of a thousand that you mention frightens me. We are talking about increases that are doubling, but not a thousand-fold. To make it more realistic, if there are conversions from oil to coal, then you cannot—it is the whole argument I am presenting—you cannot expect that a doubling of emissions will lead to a doubling of wet deposition at a specific receptor side. Within the saturated airshed this problably won't occur.

Mr. MITCHELL. I don't care about the one-on-one thing. The impression you gave me was our environment was saturated, and we couldn't do much worse than what we have now, no matter what happened. I am just saying if we didn't build a lot more coal-burning plants, is that going to make the situation worse? I can't believe that it would.

Dr. MOHNEN. It is hard to believe, and it took me some time to convince myself that the atmosphere is limited in the ability to process sulfur dioxide. That ability may be controlled by other substances, not uniquely by the SO_2 concentration.

Mr. MITCHELL. They can continue to build as extensively as they want to, and our air isn't going to get any worse than it is now?

Dr. MOHNEN. Not measurably, but you cannot project this to unreasonably high amounts. You cannot increase it by 100 times. This is not the impression that I like to leave with you.

Mr. MITCHELL. You also mentioned that we can't get a 50-percent reduction here, with the 50-percent reduction in Ohio. Reducing it 50-percent in Ohio would not affect the Adirondacks.

Dr. MOHNEN. In the Eastern United States. It is the whole Ohio Valley including Kentucky and Pennsylvania.

Mr. MITCHELL. You leave the impression initially there is no sense in our doing much about it because if they cut it 50-percent it will not help us at all.

Dr. MOHNEN. You have to start at some point.

Mr. MITCHELL. Can't we argue on the other side that is a signal for a massive crash program? The 50-percent reduction doesn't help us. Let's cut it 90 percent. Let's get some aid. Why can't you include that?

Dr. MOHNEN. Because the minute we present you with scientific proof of what can be achieved, then you have the foundation to establish that ambitious goal. But in the past it was my understanding in air pollution that you must establish as a scientist a source-receptor relationship, and based on that concept, you take action. This was the classical scientific approach to solving problems. Beyond that, it is a political approach of which you are in charge. As a scientist, we must establish this source-receptor relationship first.

Mr. MITCHELL. Can a scientist draw the conclusion that 50 percent doesn't do the job and 90 percent might? Is that a logical conclusion?

Dr. MOHNEN. It might be a conclusion, yes, but it is not a scientific conclusion. I would not dare to confront my peers with an opinion, because we have been wrong before, sir, many times, and I think it is of no help to Congress if scientists volunteer opinions, "on the one hand," and, "on the other hand."

Mr. **Mitchell.** But we are sitting on our hands right now.

Dr. **Mohnen.** We are asking and begging for a research program, and we are not getting it.

Mr. **Mitchell.** That is my next question. You mentioned the funding is not adequate to continue the research you would like to do.

Dr. **Mohnen.** Precisely.

Mr. **Mitchell.** How much more money do you need to really do the job?

Dr. **Mohnen.** I believe that a crash program of the type of CIAP, which is a good example, will suffice. Now, during CIAP, Congress approved on the order of $20 million to study the effects of supersonic transport on the stratosphere. If I may reflect on that one issue, the original threat was that supersonic transport will kill people because of depletion of ozone. The result of CIAP was, reasonable increase of aircraft traffic in a particular altitude range will increase ozone and hence decrease cancer risk.

So, again, it is not reasonable to assume what seems logical to you at the beginning. Give us a national program. Let it be administered as a research program by scientists such as those at the National Center for Atmospheric Research. They are set up to do this, but they need funds.

Mr. **Mitchell.** That is my point. How much do you need?

Dr. **Mohnen.** A minimum of $5 million per year, and give us a minimum of 3 years: and monitor us year-by-year like during CIAP. It did produce answers. It even revolutionized atmospheric sciences.

Mr. **Mitchell.** Thank you.

Just one comment I want to clear up. This 50-percent reduction example, you say there would not be maybe even a measurable decrease in the saturated area, which includes where we sit today, as well as the close reaches of Canada, but it would have an immediate impact way out in northern Canada?

Dr. **Mohnen.** I think Quebec might see an effect. I think our Canadian friends with a 50-percent reduction will be jubilant. I think the mistake that both United States and Canada is making at this time is to assume that a 20 percent emission reduction will give a 20-percent reduction of wet deposition at all receptor sites. This impression I would like to question.

Mr. **Martin.** I think you have made that point very clear in your 50 pages of testimony. I look forward to going through that.

As I have said before, areas like the Adirondacks have recognized damage. Then do something about this. If reduction doesn't help, then at least go in with protective watershed liming and put the area in a temporary holding pattern because you won't get your effects in the foreseeable future.

If the researchers are correct that there is a problem in forestry and lakes, then, to me, the meaningful approach is that we help that patient. The patient can be helped.

Perhaps we will have the opportunity to go into that this afternoon.

Speaking of patience, for my constituents and my colleagues, you are in a complex that probably has more ice sheets than any complex in the world. It is rather cool here.

Mr. CARNEY. Doctor, thank you very much for your testimony. I might say you have delivered this area a second setback. There are some who thought if the air got worse, we could go into the vinegar business, but we can't do that, either. We had better get our job done and find out the answers.

Mr. SCHEUER. We will take the last two witnesses, one after the other, and then question both of them then we will wind up the morning session about 1:15. We will hear from Dr. Dudley Raynal, associate professor, department of environmental and forest biology, school of biology, chemistry and ecology, State University of New York, Syracuse, N.Y.

Dr. RAYNAL. Thank you, Mr. Chairman, and Members of Congress. I appreciate the opportunity to present this testimony to you.

I call to your attention my lengthy testimony. I will summarize the critical points from that written testimony.

During the period from June, 1978, to August, 1980, I served as project manager for a multi-disciplinary characterization project entitled, "Potential Effects of Acid Precipitation on Terrestrial Ecosystems in the Adirondacks: A Problem Analysis."

This project was funded by the New York State Energy Research and Development Authority and included specialists in plant ecology, plant disease, forest soils, and microbiology. This effort is of particular importance to the subcommittee, and its findings will represent a major component of my testimony this afternoon.

The effects of acid precipitation on terrestrial forest ecosystems are especially important since the 12 counties which include the Adirondack Park account for about 42 percent of the commercial forest land in New York State, and about 20 percent of the State's commercial forest land, is located within the boundaries of the Adirondack Park. The forest industry contributes substantially to the long-term stability and prosperity of the region, including employment opportunities in lumbering, solid wood products, pulp and paper, recreation and tourism. Impacts upon the natural forest resource systems of the Adirondack Park certainly have the potential for widespread impacts on this segment of the New York State economy.

Let me summarize the findings of our study very briefly.

Precipitation chemistry in the Adirondack Mountains is much like that recorded at other National Atmospheric Deposition Program monitoring stations in the Northeast a volume-weighted mean annual precipitation pH is 4.15 or about 28 times more acidic than precipitation in equilibrium with carbon dioxide in the environment.

Our experiments indicate that the rates of nutrient loss from Adirondack forest soils studied exceeds inputs from precipitation. As well, sulfate output exceeds inputs from sulfate from precipitation. Sulfate is highly mobile in these soils, and sulfate from anthropogenically produced sources as well as from internally generated sources represents a serious potential threat to the nutrient status of Adirondack soils.

Here I am talking, and I want to emphasize I am talking, about unmanaged soils, unlike those that Dr. Jacobson was which are highly managed.

Current leaching levels of cations or nutrients appear to be strongly related to the translocation of sulfate as well as other organic anions through the forest soil.

At the same time, nitrate, an important nutrient that is input via day deposition or precipitation, does not appear to be harmful to forest ecosystems. In fact, the potential beneficial effect of nitrogen fertilization seems to outweigh any detrimental effect associated with hydrogen ion deposition. So, consequently, acid precipitation might stimulate, under certain conditions and for certain species, tree seedling growth, where soils are nutrient deficient. This is indicated by simulation studies of acid rain effects on tree seedling growth.

Liming of soil which has been done to some extent on an experimental basis may help to lessen detrimental acid precipitation effects in that it may help conserve some important nutrient elements. Short-term monitoring indicates this procedure is apparently not very effective in increasing sulfate retention and, therefore, plant nutrient leaching may to continue to be a problem.

I would point out that population levels and species diversity of bacteria, actinomycetes, and fungi (soil-inhabiting micro-organisms) documented in our study are similar to those of areas in other parts of the world that have been subject to extreme acidification (for example Sweden). We have found that there is reason to be concerned about the decomposition of organic matter and what that means in terms of available nutrients for plant growth. The role of acid precipitation on selection of microorganisms inhabiting organic and mineral soil horizons requires long-term study, however, to understand fully the implications of changes in the microbial flora.

Laboratory microcosm studies that precipitation acidification may increase numbers of certain microorganisms, including, some plant pathogenic forms while decreasing others.

Vegetation studies characterizing the regeneration of forest species indicate that both hardwood and conifer forests in New York State have been producing abundant supplies of propagules and are continuing to regenerate successfully. Laboratory studies indicate that simulated acid precipitation of pH 3.0, has a potential to damage early stages of growth and development of trees but to different degrees.

Tree-ring studies, that is, dendrochronological analyses of mature trees, as well as other investigations indicate that die-back is occurring in a number of Adirondack forest species, leading to concern about the relationship between die-back, forest pathogens, between atmospheric and climatic conditions and biological stress, and the complicated factors associated with additional stress that deposition may cause.

As well as die-back, however, we have discovered that through dendrochronological analysis that certain species in fact may show an increase in growth under certain kinds of circumstances. There is, therefore, conflicting evidence about effects of acid precipitation on tree growth.

I point out, in summary, that both potentially detrimental and beneficial effects of acid precipitation on forest ecosystems have been found.

Competing positive and negative effects make determination of overall effect quite difficult. It is important to recognize we are dealing with both acute effects, those that are quickly observed and pronounced, and are chronic effects, which are long-term and cumulative. Both maybe occurring and must be studied fully to fully assess effects of acid precipitation on our forests.

Finally, I would point out that subinjurious damage levels are not fully understood but must be considered as a likely additional stress or load which may operate in conjunction with adverse environmental conditions, pathogens and predators to reduce plant growth and vigor.

Thank you.

[The prepared statement of Dr. Raynal follows:]

BEFORE THE
CONGRESS OF THE UNITED STATES
HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH, AND ENVIRONMENT
OF THE
COMMITTEE ON SCIENCE AND TECHNOLOGY

STATEMENT OF DUDLEY J. RAYNAL, Ph.D.

Associate Professor, Department of Environmental and Forest Biology
State University of New York
College of Environmental Science and Forestry
Syracuse, New York 13210

My name is Dudley J. Raynal. I hold a Ph.D. degree in botany with specialization in plant ecology from the University of Illinois. I am currently an Associate Professor in the Department of Environmental and Forest Biology at the State University of New York College of Environmental Science and Forestry, Syracuse, New York. I serve as a member of the Acid Precipitation and Atmospheric Deposition working group of the Institute of Environmental Program Affairs at our College. I am also a member of the Technical Committee of the National Atmospheric Deposition Program, a member of the Working Group on Terrestrial Effects of Acid Precipitation of the Joint US/Canada Committee, which is charged with developing the basis for an agreement on transboundary air pollution, and a contributor to the US Environmental Protection Agency's Critical Assessment Document on Acid Precipitation Effects. In this latter role I have been charged with preparing materials for inclusion in that document on the effects of acid precipitation on forest ecosystems. I am the author of numerous technical publications dealing with plant ecology and have recently edited a publication entitled, "Effects of Acid Precipitation on a Forest Ecosystem" which is the final subject document of a two-year characterization study completed under contract to the New York State Energy Research Development Authority (ERDA 80-28). Sample copies of this document have been provided to Subcommittee staff. A complete copy of my curriculum vitae is attached as Appendix I.

I am presenting this statement at the invitation of the Honorable James H. Scheuer, Chairman of the Subcommittee.

INTRODUCTION

The College of Environmental Science and Forestry is a specialized College within the State University of New York with its main campus located at Syracuse, New York. It offers upper division undergraduate and graduate instruction, conducts research and coordinates public service programs in five Schools, which encompass programs in natural resources and the environment. The College operates nine regional campuses and field stations throughout New York State, including four forest properties in the Adirondack Mountains. The total area of these landholdings exceeds 25,000 acres. Much of our research on acid precipitation has been conducted on these forest properties. The College, through its Institute of Environmental Program Affairs (IEPA), coordinates multi-disciplinary research projects which span the academic schools and departments of the College. Currently, multi-disciplinary programming is coordinated through IEPA in acid precipitation and atmospheric deposition, in bio-energy research, and in sludge and sludge management research. A complete listing of current and recently completed projects dealing with atmospheric deposition and its effects is attached as Appendix I.

During the period from June, 1978 to August, 1980 I served as project manager for a multi-disciplinary characterization project entitled, "Potential Effects of Acid Precipitation on Terrestrial Ecosystems in the Adirondack Mountains: A Problem Analysis," (see Appendix II for complete description of project). This project was funded by the New York State Energy Research and Development Authority and included specialists in plant ecology, plant disease, forest soils, and organic matter decomposition. This effort is of particular significance to the Subcommittee and its findings will represent a major component of my testimony.

The effects of acid precipitation on terrestrial forest ecosystems are especially important since the twelve counties which include the Adirondack Park account for about 42 percent of the commercial forest land in New York State, and about 20 percent of the State's commercial forest land is located within the boundaries of the Adirondack Park. The forest products industry in this region is a significant component of the economic base of communities within the Adirondack Park and the region. This industry contributes substantially to the long-term stability and prosperity of the region, including employment opportunities in lumbering, solid wood products, pulp and paper, recreation, and tourism. Impacts upon the natural forest resource systems of the Adirondack Park have the potential for wide-spread impacts on this segment of New York State economy.

STATEMENT OF FINDINGS

The purpose of our terrestrial acid precipitation characterization studies has been to determine actual and potential influences of acidic precipitation on a forest ecosystem in the Adirondack Mountain region. This was accomplished by characterizing several important ecosystem components and identifying their sensitivity to acidic precipitation through field and laboratory documentation and experimental studies. Forest soils, vegetation, microorganisms and a tree disease were the major aspects considered in this investigation. The following paragraphs briefly describe the findings of the study.

Chemistry of precipitation in the Central Adirondacks (Huntington Forest) is much like that recorded at other National Atmospheric Deposition Program Monitoring stations in the Northeast. Weekly precipitation pH values ranged from 5.4 to 3.2 during late 1978 to early 1980 with a volume weighed mean annual pH of 4.15 or about twenty-eight times more acidic than rainfall in equilibrium with CO_2 in the atmosphere. Hydrogen ions comprised 66.5% of the total cationic strength of precipitation. Sulfate contributed 62.9% of the total anionic strength and nitrate 31.9%. Thus anthropogenically produced sulfur and nitrogen oxides in large measure account for the rather acidic character of precipitation of the Adirondack region (Appendix III).

Examination of leaching patterns in field characterization studies and microcosm experiments indicates that the rates of nutrient loss from the Adirondack forest soils studied exceed inputs from precipitation. As well, sulfate outputs exceed inputs of sulfate from precipitation indicating high mobility of sulfate in these soils. Leaching of nutrient bases by anthropogenically produced and internally generated sulfate represents a serious threat to the nutrient status of Adirondack forest soils. Current leaching levels of cations appear to be strongly related to translocation of sulfate through the soil profile (Appendix IV).

Inputs of nitrate from precipitation do not appear to be harmful to the forest ecosystem. The potential beneficial effects of nitrogen fertilization seemingly outweigh detrimental effects associated with hydrogen ion deposition. Consequently, acid precipitation may stimulate tree seedling growth where soils are nutrient deficient as indicated by our studies of simulated acid rain on tree seedlings.

Application of lime to soils to lessen detrimental acid precipitation effects may help conserve or replace calcium, magnesium, and potassium but short term monitoring indicates that this procedure is apparently not effective in increasing sulfate retention. Thus liming of these soils is not expected to greatly reduce base leaching.

To evaluate the consequences of changes in soil fertility on forest productivity there is need to assess tree growth under natural and experimental conditions where soil fertility levels are known. Investigations incorporating foliar analysis and growth measurements utilizing dendrometer and radial increment techniques should be used to correlate tree growth and soil nutrient status.

Population levels and species diversity of bacteria, actinomycetes, and fungi documented in this study are lower than those of similar sites in other geographical locations. The microbial flora of the Adirondack region is compositionally unlike that reported in the midwestern U.S. and Canada, but similar to that in Sweden. Nitrifying bacteria, sensitive to acidic conditions, were found to be absent from both hardwood and conifer stands where substrate pH ranged from 3.1 to 4.1 but were found in a red pine plantation with pH of 4.1 to 5.6 and at Natural Bridge, NY site with soil pH of 6.1 (Appendix V).

The extent to which the mycoflora of these sites is comprised of acid tolerant or acidophilic genera and species is not clear, and demands further experimental studies. The role of acid precipitation on selection of microorganisms inhabiting organic and mineral soil horizons also requires long-term field monitoring to assess natural population levels and laboratory studies evaluating organism responses to various acidity regimes.

Microcosm studies and field inventory indicate that under natural forest conditions precipitation acidification may increase activities and population levels of certain microorganisms in the mineral soil, particularly some fungi and actinomycetes, while decreasing others, particularly bacteria. The role of changing microbial communities on nutrient cycling demands further coordinated research.

Vegetation studies characterizing regeneration dynamics of forest trees indicate that both hardwood and conifer forests have been producing abundant supplies of propagules and seedlings insuring the continued development of these stands. Forest litter layers, the site of seed germination and seedling establishment, buffer juvenile plants from measurable injurious acid precipitation effects under natural forest conditions. Damage to early life cycle stages of trees, including seed germination, early seedling growth and development and pollen viability, represents a serious potential problem demonstrated in various laboratory dose- response germination and seedling growth studies. Progressive precipitation acidification and long term exposure to acidic deposition causing greater canopy, litter, and humus leaching may produce damage to regenerating trees in forest stands in the future (Appendix VI).

Dendrochonological investigations of the growth response of mature conifers on uncut, relatively undisturbed sites in the Adirondack Mountains suggest that acid precipitation may result in contrasting growth responses by trees. Since 1965 growth of red spruce on two separate but adjacent sites has been poorer than expected based on climatic conditions during the period. Conversely, on a different, relatively fertile site white pine growth has been greater than expected since 1965 based on climatic conditions. Dendrochronological methodology is not likely to repoduce conclusive evidence regarding tree response to acid precipitation because numerous unmeasured interacting abiotic and biotic factors simultaneously regulate tree growth. However, the findings warrant further investigation through continued monitoring of tree growth and age structure analyses and suggest that these potentially susceptible or responsive species be examined in an experimental mode to evaluate cause-effect relationships of acid precipitation effects on growth and vigor (Appendix VII).

Studies of Scleroderris canker of pines indicate that fungus pathogen spore germination and germ tube elongation are not seriously reduced by acidity levels found in incident precipitation although highly acidic rain episodes may not favor infection by the pathogen. Characterization studies indicate that all New York isolates of the pathogen belong to a common (European or Intermediate) strain, thus differing from most Canadian and Lake State isolates. There is no evidence at present that acid precipitation contributes to increased incidence of Scleroderris canker disease. Further experimental studies are required which evaluate the poorly known mechanism of the disease infection process and its possible relation to acid precipitation. The influence of environmental and biological variables on the behavior of facultative saprobes which may shift to pathogenic behavior awaits further investigation (Appendix VIII).

Appendix I. Personal Vita of Dudley J. Raynal

152 Tejah Avenue

Telephone: Office: (315)470-6782
Dept. Office: 470-6760
Home: 478-0531

Date of Birth: January 1, 1947 Place: Greenville, SC

Marital Status: Married, 2 children

Present Position: Associate Professor
Department of Environmental and Forest Biology
College of Environmental Science and Forestry
State University of New York
Syracuse, NY 13210

Education: Ph.D. University of Illinois, Urbana-Champaign, IL
Department of Botany, 1974 (Plant Ecology)

B.S. Clemson University, Clemson, SC
Biology, 1969 (Biology)

Affiliations: Sigma Xi

Phi Kappa Phi

Gamma Sigma Delta

Alpha Zeta

Membership: American Association for the Advancement of Science

Botanical Society of America

British Ecological Society

Ecological Society of America

Military Experience: United States Army Reserve

1975 - 1980 (inactive) CPT, Corps of Engineers

1970 - 1975, 1 LT, CE

1974 - Engineer Officer Basic Course, Ft. Belvoir, VA

1969 - 1970 2 LT, Medical Service Corps

Previous Positions: 1974 - 1978 Assistant Professor, SUNY College of Environmental Science and Forestry, Department of Forest Botany

1974 - Visiting Lecturer, University of Illinois, Department of Botany

1970 - 1973 Teaching Assistant, University of Illinois, Department of Botany

Personal Vita of Dudley J. Raynal

Teaching Experience:

Plant Ecology, Plant Population Ecology, Systematic Botany (Syracuse Campus)

Adirondack Flora (Cranberry Lake Biological Station, NY)

Plant Ecology, Plant Taxonomy, Plant Geography (University of Illinois)

Research Interests:

Plant population and community ecology, Plant demography and life history development, Plant succession

Ph.D. Dissertation:

"Population dynamics of annual plants of early successional communities" (1974)

Awards:

National Science Foundation Traineeship, University of Illinois 1969-73

Financial Support:

1980 - 1982 Measurement of Precipitation Chemistry at the Huntington Wildlife Forest, NY. New York State Electric and Gas Company. ($14,825)

1980 - 1981 Acid Precipitation in an Adirondack Forest Ecosystem: Effects on Tree Regeneration ($10,870). McIntire-Stennis Program USDA/SEA.

1978 - 1980 Potential Effects of Acid Precipitation on Terrestrial Ecosystems on the Adirondack Mountains. New York State Energy Research Development Authority. (Principal Investigator) ($195,512)

1978 - Studies of Littoral Vegetation of the St. Lawrence River. U.S. Fish and Wildlife Service, Department of Interior $8, 740

1977 - 1978 Demography of *Picris hieraciodes* L. SUNY Research Foundation grant-in-aid $3,500

1975 - 1977 Comparative Studies in *Hieracium* (Compositae). SUNY Research Foundation $2,200

Administrative Responsibilities:

1981 - Regional Editor, Journal of Environmental/Experimental Botany

1977 - present College representative to National Atmospheric Deposition Program (USDA Project NC-141)

1975 - 1978 Biology Curriculum Coordinator

Personal Vita of Dudley J. Raynal

Graduate Student Advisement:

Major professor for several Ph.D. and M.S. candidates. I serve as committee member for several graduate students pursuing degrees both at SUNY-CESF and at Syracuse University.

Graduate Student Theses Completed Under My Supervision:

1978 Klemow, K.M. Plant population patterning and community development in a limestone quarry (M.S. Thesis)

1979 Bonkoungou, G.J.E. Tree population dynamics in relation to climate and forest history in the Oswegatchie Plains, Northern New York (Ph.D. Dissertation)

1980 Guobis, T.J. Immigration and establishment of *Centaurea maculosa* in a central New York limestone quarry (M.S. Thesis)

1981 Raleigh, F.S. Population ecology of the monocarpic perennial plant *Picris hieracioides* L. on contrasting sites. (M.S. Thesis)

Departmental Responsibilities:

Curator, Vascular Plant Herbarium. The College herbarium contains approximately 30,000 specimens of vascular plants and is particularly strong in the flora of the region. The collection serves teaching and research needs at the College. As curator, I am responsible for acquisitions and maintenance of the collection and for coordinating loans and exchanges.

Papers Presented:

1970. "Weed population dynamics on prairie and forest soils in central Illinois," an invited paper co-authored with F.A. Bazzaz. Presented at the symposium on plant population dynamics at the AAAS meetings in Chicago, December.

1971. "Some factors affecting the development of weed populations on prairie and forest soils in east-central Illinois," co-authored with F.A. Bazzaz. Presented at the AIBS meetings at Boulder, CO, August. Bulletin Ecological Society America 52:34 (Abstract).

1973. "Population response of *Ambrosia artemisiifolia* to interference with winter annuals," co-authored with F.A. Bazzaz. Presented at the AIBS meetings at Amherst, MA, June.

1975. "Early successional plant community develpment of contrasting adjacent soils," an invited paper given at the Fifth Soil Microcommunities Conference, Syracuse, NY, October.

Personal Vita of Dudley J. Raynal

Papers Presented (cont.)

1977. "Plant population patterning and community development in a limestone quarry," co-authored with K.M. Klemow. Presented at AIBS meetings, E. Lansing, MI, August. Bulletin Ecological Society America 58:16 (Abstract).

1977. "Differential population response of *Centaurea maculosa* Lam. on two limestone quarry substrates. Co-authored with T.J. Guobis. Presented at AIBS meetings, E. Lansing, MI, August. Bulletine Ecological Society America 58:41 (Abstract).

1978. "The population dynamics of *Melilotus alba* in a limestone quarry." Presented at AIBS meetings, Athens, GA, August. Bulletin Ecological Society America 59:110 (Abstract).

1979. "The population ecology of *Erucastrum gallicum* (Cruciferae) AIBS Meetings, Stillwater, OK. Bulletin Ecological Society America 60:112 (Abstract). With K.M. Klemow.

1979. "The demography of *Melilotus alba*, an obligate biennial. Botanical Society of America, Publ. 157:27. (Abstract) With K.M. Klemow.

1980. "Acid precipitation in New York State: Effects on New York State Forests" Presented to New York State Power and Pool, and Empire State Electric Energy Research Corporation Acid Precipitation Seminar.

1981. "Effects of acid precipitation on a forest ecosystem in the Adirondack Mountains, New York. Presented at America Meterological Society Conference on Long-Range Transport of Air Pollutants, Albany, NY.

Publications:

1973. Raynal, D.J. and F.A. Bazzaz. Establishment of early successional plant populations on forest and prairie soil. Ecology 54:1135-1341.

1975. Raynal, D.J. and F.A. Bazzaz. Interference of winter annuals with *Ambrosia artemisiifolia* in early successional fields. Ecology 56:35-49.

1975. Raynal, D.J. and F.A. Bazzaz. The contrasting life cycle strategies of three summer annuals found in abandoned fields in Illinois. Journal of Ecology 63:587-595.

1977. Raynal, D.J. Flowering plant systematics. A lecture and laboratory guide. (Revised edition, 1980).

Personal Vita of Dudley J. Raynal

Publications (cont.)

1978. Raynal, D.J. and Geis, J.W. Winter Studies of Littoral Vegetation. In "Environmental Assessment of the FY 1979 Winter Navigation Demonstration on the St. Lawrence River," J. W. Geis (ed.).

1979. Raynal, D.J. Population dynamics of *Hieracium florentinum* (Compositae) in a central New York Limestone Quarry. Journal of Applied Ecology 16:287-298.

1980. Raynal, D.J., A.L. Leaf, P. L. Manion, and C.J.K. Wang. Actual and potential effects of acid precipitation on an Adirondack Forest Ecosystem. New York State Energy Research and Development Authority. Report 80-28.

1981. Klemow, K.M. and D.J. Raynal. Population ecology of *Melilotus alba* in a limestone quarry. Journal of Ecology 69:33-44.

1981. Geis, J.W., G.J. Schumacher, D.J. Raynal, and N.P. Hyduke. Distribution of *Nitellopsis obtusa* (Charophyceae, Characeae) in the St. Lawrence River: A new record for North America. *Phycologia* 20(2).

1981. Mollitor, A.V. and D.J. Raynal. Acid precipitation and ionic movements in Adirondack Forest Soils. Submitted to Soil Science Society of America Journal.

1981. Raynal, D.J., J.R. Roman, and W.M. Eichenlaub. Response of tree seedlings to acid precipitation. I. Effect of substrate acidity on seed germination. Submitted to Journal of Environmental and Experimental Botany.

1981. Raynal, D.J., J.R. Roman, and W.M. Eichenlaub. Response of tree seedlings to acid precipitation. II. The effect of simulated canopy throughfall on sugar maple seedling growth. Submitted to Journal of Enviornmental and Experimental Botany.

Appendix II.

ACID PRECIPITATION AND ATMOSPHERIC DEPOSITION PROJECTS

State University of New York
College of Environmental Science and Forestry

Seven acid precipitation and atmospheric deposition research projects are ongoing or recently completed at the College. Total funds in support of these projects is $452,814. Sponsors include Federal and State governments, private corporations and nonprofit research organizations. An annotated list of atmospheric deposition research projects is given below.

210-6204A
"Effect of Atmospheric Sulfur Pollutants Derived from Acid Precipitation on the Benthic Dynamics of Lakes in the Northeastern United States." US Department of Interior (USDI-OWRT). M.J. Mitchell. 10/1/79-9/30/82... $127,645.

This study will determine the impact of sulfur inputs derived from acid precipitation on the sulfur dynamics of specific lakes within New York. An understanding of these dynamics will be a prerequisite for developing ameliorative procedures for restoring water quality and lake productivity. This information will aid in assessing the cost/benefit ratios in the utilization of fuels with high sulfur content. In addition, this research will enhance our assessment of the overall role of sulfur as a nutrient, exchange cation and alternate electron acceptor in limnetic systems. This determination will further the development of models for predicting rates of decomposition and nutrient flux in heterotrophic sediments.

In order to determine how lake characteristics will affect these dynamics, Oneida Lake, which is eutrophic and alkaline, will be contrasted to Deer Lake, which is dysotrophic and acidic. The qualitative forms and quantitative amounts of sulfur constituents will be determined in the water column and sediment. The major taxa of both the meso- and macro-invertebrates of the benthos will be identified and quantified since they will affect the sulfur dynamics of the sediment. Laboratory microcosms will be employed to determine the effect of sulfate, the major form of anthropogenic sulfur input, on carbon and sulfur dynamics in the sediments. These dynamic formulations will be incorporated into a computer simulation model for predicting decomposition rates and sulfur fluxes. The model will allow long term predictions of how acid precipitation via sulfate input will affect sediment dynamics and overall lake quality.

210-6153A
"Potential Effects of Acid Precipitation on Terrestrial Ecosystems in the Adirondack Mountains: A Problem Analysis." New York State Energy Research and Development Authority (NYSERDA). D.J. Raynal. 6/2/78-8/31/80...$195,805 (with P.D. Manion, A.L. Leaf and C.J. Wang).

The purpose of this two-year research effort is to determine actual and potential influences of acidic precipitation on a forest ecosystem in the Adirondack Mountain region. This objective is being accomplished by characterizing several important ecosystem components and identifying their sensitivity to acid precipitation through field and laboratory documentation and experimental studies. Precipitation chemistry, forest soils, vegetation, microorganisms and tree disease have been the major aspects considered in this investigation. Having pursued characterization and experimental studies in an integrated manner, it is possible not only to draw conclusions regarding acid precipitation effects for each study phase but also to identify ecosystem linkages or component relationships that are critical in assessing acid precipitation impacts on the forest ecosystem.

210-6221A
"Effects of Acid Precipitation on Scleroderris Canker." US Department of Agriculture (USDA-FS). P.D. Manion. 5/29/80-6/30/82...$20,000.

The impact of Scleroderris canker on pine stands varies from one location to another. Some of the variation can be attributed to climatic conditions associated with topographic features, but the cause of much of the variability is unknown. This study has been initiated to assess the impact, both direct and indirect, of "natural" acid rain and artificially produced acid rain on the development of Scleroderris canker on red pine seedlings. Acidified rain produces direct effects on leaf surfaces and indirect effects on plant health through leaching of required cations from the soil. Both effects will be investigated in this study to evaluate the relationship of such changes on Scleroderris canker development. Experimental plantings established during a related study (210-6153A) will be maintained with additional plots established for replicating and broadening the data base. Soil pH, nutrients and Scleroderris canker development will be determined at weekly intervals for artificially acid treated, natural acid treated, and control plots.

210-6235B
"Measurement of Precipitation at the Huntington Wildlife Forest." New York State Electric and Gas Corporation (NYSEG). D.J. Raynal. 6/2/81-5/28/82...$8,831.

This project is designed to support the operation of a precipitation monitoring station in the Central Adirondack Mountains. The station will be located at the Archer and Anna Huntington Wildlife Forest, Newcomb, New York and is one of approximately sixty sites forming the precipitation monitoring network of the National Atmospheric Deposition Program (NADP). Weekly precipitation samples and bimonthly dry deposition samples will be collected year round and analyzed for pH and specific conductance. Supporting weather information collected daily will also be amassed. All information will be forwarded to the NADP Central Analytic Laboratory (CAL) where chemical constituents of the samples will be characterized. The technical information collected will support the College's research efforts in determining the actual and potential effects of acid precipitation on certain Adirondack forest ecosystems. Precipitation chemistry data constitute critical information in assessing nutrient status, growth, and productivity of regenerating hardwood forest stands. This data collection will form a significant component of climatological measurements in the College's longterm ecological research at the Huntington Forest.

228-5016A, 210-6260A
"The Effects of Acid Precipitation on Smallmouth Bass." Bass Research Foundation and USDI Fish and Wildlife Service. R.G. Werner (in cooperation with SUNY Oswego). 5/15/80-9/30/81...$14,654.

Acid precipitation adversely affects soft water lakes and streams exhibiting a poor buffering capacity. Preliminary data from lakes in the Adirondack Mountains indicates that low pH occurs especially during the spring snowmelt period. This pH depression most seriously affects spring spawners such as smallmouth bass. This study will investigate the impact of acid precipitation on early developmental stages and reproduction of this species. Laboratory bioassays will be conducted to determine what effects pH depression may have on egg hatchability, survival and growth of fry and juveniles, and reproduction. Histopathological and behavioral investigations will also determine how pH depression is affecting the species. Field studies will focus on impacted bass lakes in the Adirondacks and will include verification of experimental results, documentation of pH depression effects on population dynamics, and a pilot study on management techniques to alleviate the effects of low pH on smallmouth bass during the critical spawning period.

210-6226A
"Emission Source Apportionment by Scanning Electron Microscopy and X-ray Fluorescence Analysis of Aerosol Samples." Environmental Protection Agency. D.L. Johnson. 7/21/80-7/20/81...$75,000 (with R.B. Hanna).

This project was designed to provide an evaluation of the role for Individual Particle Analysis (IPA) via computer assisted Scanning Electron Microscopy with Energy Dispersive X-ray Analysis (SEM/EDXA) as it relates to particle source identification and subsequent emmision source apportionment. Since particles have distinct identities which are amenable to direct measurement through recent advances in IPA, it may be possible to refine and more clearly focus source apportionment analyses carried out by the Chemical Element Balance approach (CEB). Utilizing IPA in conjunction with CEB based upon bulk analysis promises to put particle source identification and relative contribution to Total Suspended Particulates (TSP) loadings on a firm and objective basis. However, the fundamental question of IPA comparison to substantial bulk analysis procedure must first be addressed and evaluated so that the limitations of this new perspective can be made clear. This project has been initiated to examine the limitations of IPA via computer assisted SEM/EDXA in the context of extant EPA aerosol collection procedures and evaluation mechanisms.

210-L025J
"Acid Precipitation in an Adirondack Forest Ecosystem: Effects on Tree Regeneration." US Department of Agriculture, State Cooperative Research Service. D.J. Raynal. 10/1/80-9/30/81...$10,870.

A major aspect of the problem of acid precipitation on forests is its effect on tree regeneration. This study will: characterize the reaction, specific conductance, and primary chemical constitutents of precipitation at the Huntington Wildlife Forest in the Adirondack Mountains; analyze changing patterns of forest growth and stand development by utilizing tree age and size structural analysis; inventory seedlings of commercially important tree species in second growth and heavily thinned or clear-cut forest stands to provide a base-line of information; determine the influence of simulated acid rain on tree seedlings grown under different soil fertility conditions, and integrate the above findings to provide a basis for further evaluation of sensitivity of forest stand dynamics and forest production to acid precipitation impact.

APPENDIX III. Atmospheric Deposition at the Huntington Wildlife Forest, New York

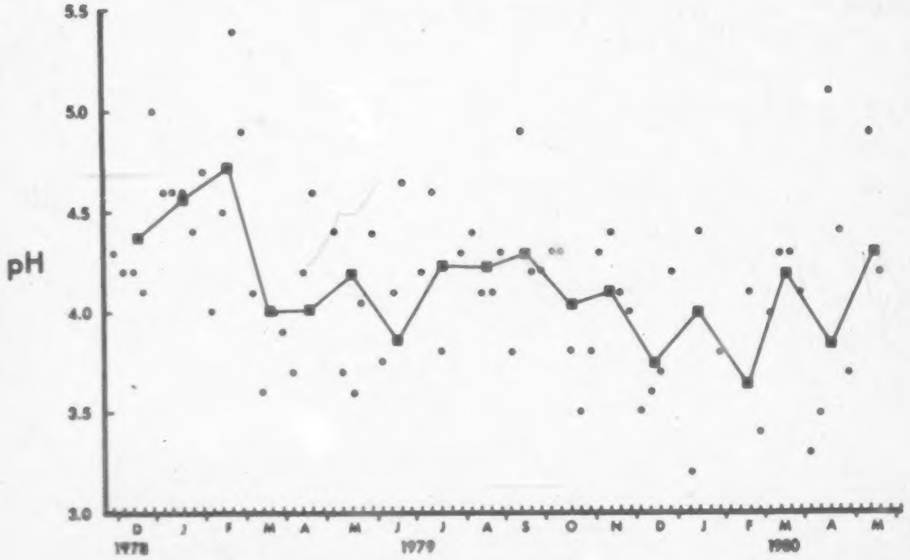

Figure 2-1. Plot of weekly wet precipitation pH sampled at the Huntington Wildlife Forest from December 1978 to 1980. Connected squares indicate the volume weighted monthly average pH.

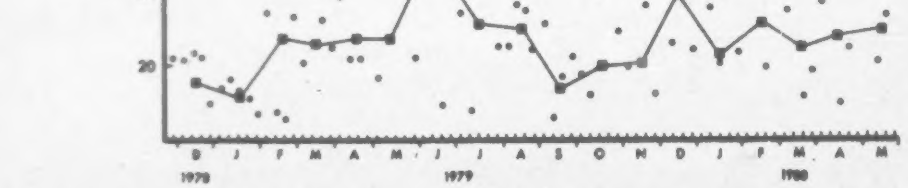

Figure 2-2. Plot of weekly wet precipitation conductivity sampled at the Huntington Wildlife Forest from December 1978 to 1980. Connected squares indicate the volume weighted monthly average conductivity.

VOLUME WEIGHTED CONCENTRATIONS AND DEPOSITIONS OF VARIOUS IONS IN PRECIPITATION AT THE HUNTINGTON WILDLIFE FOREST. THE SAMPLE PERIOD FOR WET DEPOSITION IS DECEMBER 1978 TO NOVEMBER 1979, AND FOR DRY DEPOSITION IS NOVEMBER 1978 TO OCTOBER 1979

Ion	Mean Concentration μeq/l	Wet Deposition kg/ha	Dry Deposition kg/ha
Ca^{++}	5.21	1.253	0.481
Mg^{++}	1.79	0.261	0.111
K^+	0.46	0.218	0.428
Na^+	7.18	1.975	0.277
NH_4^+	7.84	1.724	0.591
H^+	42.96	0.520	0.028
NO_3^-	22.55	16.746	2.323
Cl^-	3.27	1.488	0.151
$SO_4^=$	46.17	26.555	3.976
$PO_4^=$	0.07	0.036	0.147

APPENDIX IV. Adirondack Forest Soils Characterization and Sensitivity to Acid Precipitation

CHEMICAL CHARACTERISTICS OF STUDY SITE SOILS (MEANS FOR TWO PITS IN EACH SITE)

Horizon	Organic Matter, %	Cation Exchange Capacity, me/100g	Reaction, pH	Exchangeable Bases, me/100g K^+	Ca^{++}	Mg^{++}	Na^+
			HARDWOOD SITE				
01	79.8	45.6	4.3	0.19	3.08	0.62	0.01
02	41.7	64.8	3.6	0.24	2.27	0.36	0.01
A2	2.3	4.2	3.9	0.08	0.49	0.07	0.01
B21h	14.9	30.3	4.5	0.16	1.04	0.18	0.01
B22hir	15.1	31.8	4.9	0.04	0.10	0.03	0.01
B23	4.3	21.5	5.1	0.01	0.06	0.01	0.00
C1X	1.6	3.4	5.1	0.02	0.05	0.01	0.00
			CONIFER SITE				
01	92.2	61.4	4.3	0.54	2.32	0.42	0.00
02	83.8	108.9	3.4	0.15	1.07	0.64	0.04
A2	1.2	3.8	3.6	0.04	0.08	0.04	0.01
B21h	14.8	29.0	4.2	0.10	0.14	0.12	0.02
B22hir	15.9	38.2	4.9	0.05	0.02	0.02	0.02
B23	6.2	15.6	4.7	0.02	0.03	0.01	0.00
C1X	2.0	5.1	4.7	0.01	0.05	0.01	0.00

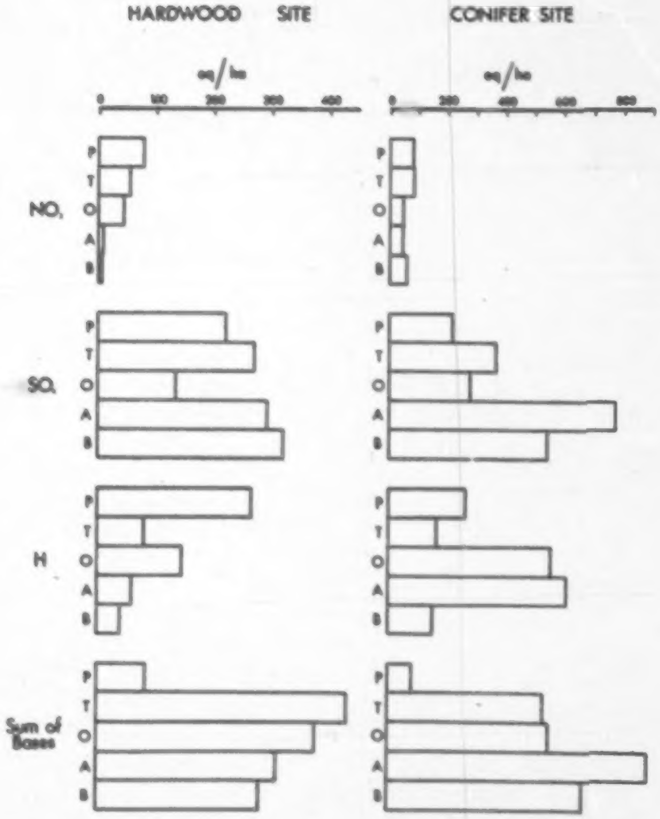

Figure 3-3. Flux of nitrate, sulfate, hydrogen, and summed bases through five hardwood and conifer ecosystem strata for the period August 8 to November 21, 1979. Note that conifer site scale is 2X hardwood site scale.

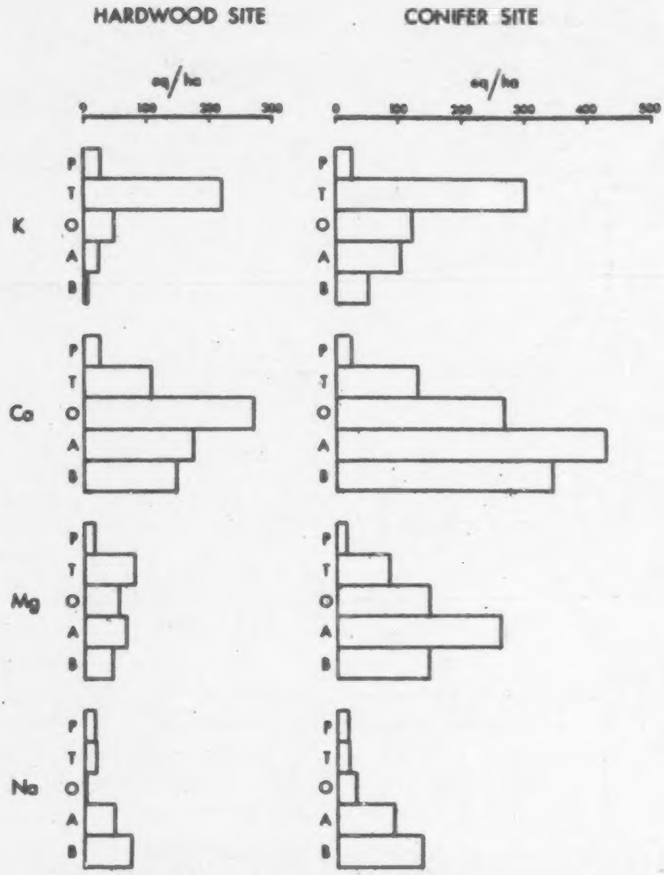

Figure 3-4. Flux of potassium, calcium, magnesium, and sodium through five hardwood and conifer site ecosystem strata for the period August 8 to November 21, 1979.

HARDWOOD SITE ION FLUX (EQ/HA) FOR THE PERIOD AUGUST 8 TO NOVEMBER 21, 1979

Ecosystem Stratum	cm H_2O	eq/ha										
		NO_3^-	$SO_4^=$	H^+	K^+	Ca^{++}	Mg^{++}	Na^+	Σ Bases	Σ Cations	Σ Anions	Diff.
Bulk precip.	46	78	219	267	27	25	16	17	84	352	296	+ 56
Throughfall	36	54	270	81	220	112	80	19	431	512	325	+187
O horizon	15	44	135	146	49	226	56	6	376	522	179	+343
A horizon	15	8	292	60	24	173	66	48	311	371	300	+ 71
B horizon	15	7	320	39	12	150	44	75	281	320	327	- 7
Net flux	31	71	-101	228	15	-125	-28	-58	-197	32	-31	-

CONIFER SITE ION FLUX (EQ/HA) FOR THE PERIOD AUGUST 8 TO NOVEMBER 21, 1979

Ecosytem Stratum	cm H_2O	eq/ha										
		NO_3^-	$SO_4^=$	H^+	K^+	Ca^{++}	Mg^{++}	Na^+	Σ Bases	Σ Cations	Σ Anions	Diff.
Bulk precip.	46	78	219	267	27	25	16	17	84	352	296	+ 56
Throughfall	33	83	371	166	303	130	84	20	537	703	454	+249
O horizon	23	44	281	563	120	262	147	26	555	1118	324	+794
A horizon	23	44	772	615	103	423	257	89	872	1487	816	+671
B horizon	23	58	548	151	53	342	147	129	671	823	606	+217
Net flux	23	20	-329	116	- 26	-317	-131	-112	-587	-471	-310	-

APPENDIX V. Microbial Populations in Adirondack Forest Soils

TOTAL NUMBER OF BACTERIA, NON-SYMBIOTIC NITROGEN-FIXING AEROBIC BACTERIA, AND ACTINOMYCETES IN THOUSANDS PER GRAM OF DRY SUBSTRATE RECORDED ON SODIUM CASEINATE AGAR AND AZOTOBACTER AGAR FROM DECEMBER 1978 TO NOVEMBER 1979

Collection Date	Bacteria on Sodium Caseinate Agar				Non-symbiotic Nitrogen-fixing Aerobic Bacteria on Azotobacter Agar				Actinomycetes, Sodium Caseinate Agar			
	Hardwood		Conifer		Hardwood		Conifer		Hardwood		Conifer	
	Soil	Litter	Soil	Litter	Soil	Litter	Soil	Litter	Soil	Litter	Soil	Litter
Dec 13	T*	T	T	T	162	T	387	2,018	3	70	32	44
Jan 10	1,555	15,165	1,585	44,142	545	9,793	833	10,209	18	410	4	62
Feb 7	7,273	4,615	598	9,585	11,247	2,308	269	3,523	42	190	17	200
Mar 7	2,532	25,847	948	20,286	897	7,288	226	8,929	17	420	9	520
Apr 4	3,536	8,947	-**	-	1,179	4,453	-	-	62	566	-	-
May 16	1,235	32,184	1,260	30,303	463	12,759	969	9,371	15	574	58	816
June 13	1,993	35,484	183	16,058	748	42,903	588	14,599	33	48	61	97
July 11	1,473	9,456	19,048	6,504	618	5,059	12,857	2,846	18	331	-	487
Aug 8	8,701	44,994	545	47,226	1,261	10,133	409	13,459	38	120	7	236
Sept 5	4,395	9,915	7,350	30,030	417	9,207	2,221	21,021	42	283	107	150
Oct 3	3,889	119,403	3,116	2,092	1,875	59,701	1,484	13,947	28	746	30	209
Oct 31	4,195	43,876	1,667	25,368	2,517	43,876	1,333	19,640	-	366	-	163
Nov 28	3,339	11,788	1,477	4,248	3,005	6,680	2,207	5,309	25	196	51	106

T* no data; Trichoderma spp. covered Petri dishes

-** no data or not sampled

FREQUENCY, % (NUMBER OF MONTHS IN WHICH A SPECIES WAS PRESENT/TOTAL NUMBER OF MONTHLY SAMPLES X 100) OF SELECTED SOIL AND LITTER FUNGI ISOLATED ON DPY AGAR BETWEEN DECEMBER 1978 TO NOVEMBER 1979

	Hardwood		Conifer	
	Soil	Litter	Soil	Litter
Deuteromycetes				
Beauveria bassiana	9	0	0	0
Gliomastix murorum var. felina	0	0	0	9
Metarrhizium anisopliae	9	0	0	0
Penicillium canescens series	55	91	45	82
Penicillium thomii	82	100	0	64
Thysanophora canadensis	0	0	0	18
Thysanophora penicillioides	0	0	0	45
Tolypocladium cylindrosporum	9	9	55	18
Tolypocladium geodes	9	9	36	0
Trichoderma polysporum	45	64	36	82
Trichoderma spp.	100	73	73	100
Zygomycetes				
Mortierella isabellina	91	100	91	91
Mortierella parvispora	73	91	100	82
Mortierella ramanniana	36	73	27	73
Mortierella vinacea	27	45	27	82
Unknown WF 2	73	9	100	55
Unknown WF 3	55	0	9	9
Unknown WF 4	36	45	73	73
Unknown WF 5	45	55	55	55
Unknown WF 6	73	64	55	55
Oomycetes				
Pythium (?) spp.	82	27	82	64

FREQUENCY, (% NUMBER OF MONTHS IN WHICH A SPECIES WAS PRESENT/ TOTAL NUMBER OF MONTHLY SAMPLES X 100) OF SOIL AND LITTER FUNGI ISOLATED ON MYCOBIOTIC AGAR BETWEEN DECEMBER 1978 TO NOVEMBER 1979

	Hardwood		Conifer	
	Soil	Litter	Soil	Litter
Deuteromycetes				
Acremonium sp	9	0	0	10
Beauveria bassiana	0	0	0	10
Chaetosphaeropsis pakistanica	9	0	0	0
Cladosporium spp.	0	36	0	0
Exophiala jeanselmei	18	9	0	20
Geomyces asperulatus	100	100	100	100
Geomyces pannorus	9	9	9	10
Gliocladium sp.	9	0	0	10
Metarrhizium anisopliae	0	0	0	10
Oidiodendron citrinum	27	27	81	70
Oidiodendron griseum	0	18	61	40
Oidiodendron maius	0	0	9	0
Paecilomyces carneus	81	72	45	30
Paecilomyces sp AP241	27	27	45	30
Penicillium canescens series	9	90	9	60
Phialophora americana	0	0	18	10
Phialophora sp AP128	0	0	9	20
Rhinocladiella sp.	9	0	0	0
Septonema sp. 1	9	54	0	20
Septonema sp. 2	0	0	0	10
Sporothrix sp.	100	27	18	0
Tolypocladium cylindrosporum	9	0	18	0
Tolypocladium geodes	9	0	18	0
Verticillium bulbillosum	81	45	72	50
Verticillium fusisporum	0	9	27	30
Verticillium fungicola	18	0	0	10
Verticillium sp.	0	0	27	0
Unknown # 1 (AP2545)	36	0	45	0
Unknown # 2	0	9	9	21
Zygomycetes				
Absidia	9	0	9	0
Mortierella sp.	0	9	0	10

APPENDIX VI. Effects of Acid Precipitation on Adirondack Forest Vegetation

FINAL GERMINATION PERCENTAGES FOR FIVE SPECIES UNDER SEVERAL GERMINATION pH TREATMENTS. TREATMENTS FOLLOWED BY THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT AT THE 5% LEVEL BY THE TUKEY'S TEST FOLLOWING ARCSIN TRANSFORMATION

Species	Treatment pH			
	5.6	4.0	3.0	2.4
Sugar maple	99.3a	98.7a	99.0a	-
Red maple	5.5a	2.2ab	1.4b	-
Hemlock	37.7a	38.0a	35.7a	4.3b
Yellow birch	67.1a	62.9a	50.7b	-
White pine	9.1a	14.4b	35.9c	41.3c

RADICLE GROWTH OF SUGAR MAPLE AND HEMLOCK UNDER VARIOUS pH TREATMENT LEVELS. EXPERIMENT 1 AND 2 USING SUGAR MAPLE DIFFERED IN THE pH TREATMENT LEVELS WERE RUN FOR FOUR DAYS. THE HEMLOCK EXPERIMENT WAS RUN FOR EIGHT DAYS. VALUES NOT FOLLOWED BY THE SAME LETTER ARE SIGNIFICANTLY DIFFERENT AT THE 5% LEVEL BY TUKEY'S TEST.

TREATMENT	TREATMENT pH				
	2.4	3.0	3.4	4.0	5.3
			SUGAR MAPLE		
1	6.7a	9.0a	-	-	12.7b
2	4.8a	7.5a	13.3b	12.0b	-
			HEMLOCK		
	1.00a	3.75b	4.86b	4.00b	-

MEAN VALUES FOR SEVERAL VARIABLES DESCRIBING GROWTH AND INJURY OF SEEDLINGS IN THE FIRST SUGAR MAPLE THROUGHFALL EXPERIMENT. VALUES NOT FOLLOWED BY THE SAME LETTER ARE SIGNIFICANTLY DIFFERENT AT THE 5% LEVEL BY TUKEY'S TEST.

	TREATMENT pH			
Variable	2	3	4	5.6
Leaf wt., mg	41	139a	93b	91b
Total wt., mg	77	270	219	210
Height 4 wks., cm	10.0	13.3	11.8	12.8
Height 5 wks., cm	16.7	29.6a	24.2ab	22.9b
Height 9 wks, cm	19.2	37.2a	31.2ab	29.0b
% with visible damage at 9 wks.	100%	35%	4%	0%

MEAN VALUES FOR SEVERAL VARIABLES DESCRIBING GROWTH AND INJURY OF SEEDLINGS IN THE SECOND SUGAR MAPLE THROUGHFALL EXPERIMENT. VALUES NOT FOLLOWED BY THE SAME LETTER ARE SIGNIFICANTLY DIFFERENT AT THE 5% LEVEL BY TUKEY'S TEST.

	TREATMENT pH			
	2	3	4	5.6
Leaf wt., mg	214	244	242	236
Twig wt., mg	54	58	58	61
Root wt., mg	96a	148b	160b	132b
Total wt., mg	363a	450b	460b	429ab
Height 7 wks., mm	41.7	45.2	46.6	44.6
Leaf length 7 wks., mm	73.6a	87.0b	87.8b	84.9b
Leaf width 7 wks., mm	49.2	51.8	51.4	51.5
% with damage greater than 1 at 7 wks.	87.0	3.8	0	4.0
% with secondary growth	34.8	0	0	0

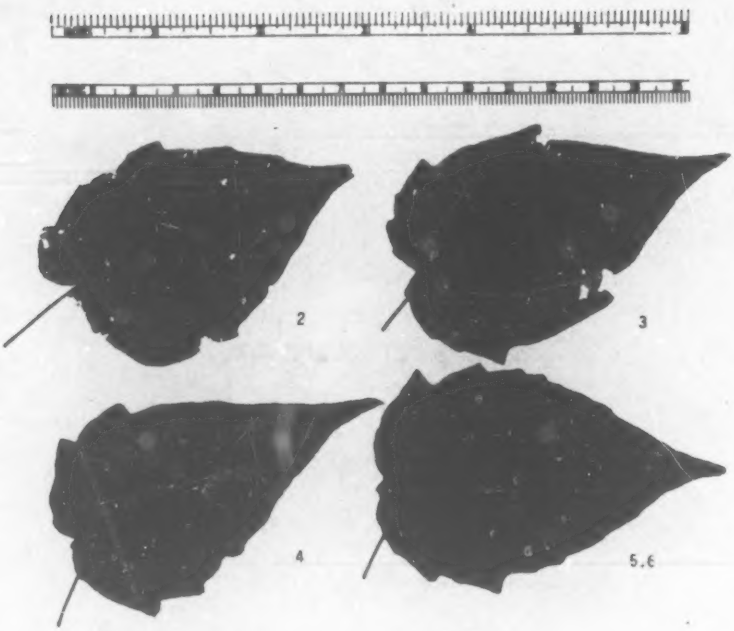

Figure 4-12. Representative leaves from the second sugar maple acidified throughfall experiment. The treatment pH is indicated below each leaf.

APPENDIX VII. Dendroecological Studies of Red Spruce and White Pine

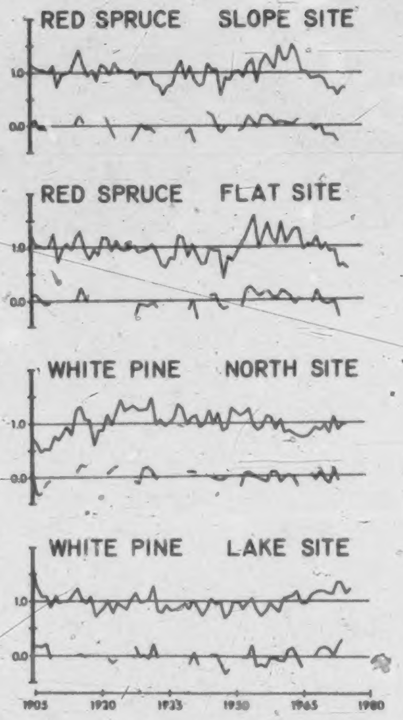

Figure 4-5. Growth of two populations of red spruce and white pine. The upper line in each graph shows the ring width index. The lower shows the residual of the regression of ring width index against climatic variables (see text).

APPENDIX VIII. Forest Pathology and Acid Precipitation Effects

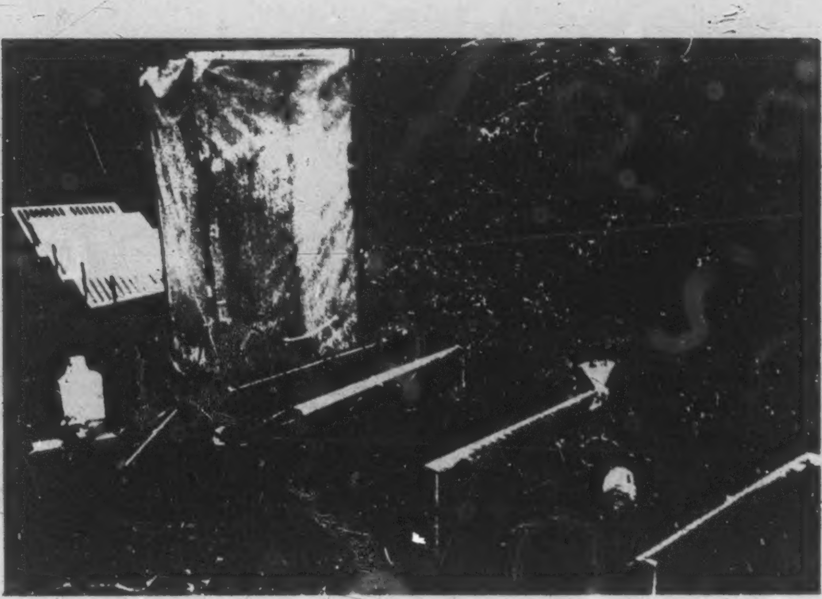

Figure 6-1. View of acid rain plots undergoing simulated rain treatment at Boonville, N.Y.

PERCENTAGE INFECTION OF RED PINE SEEDLINGS ASSOCIATED WITH VARIOUS TREATMENTS (PLOTS REPRESENT 7 TO 29 TREES).

Covered Plots	Natural Rain to Soil	pH 3.5 Rain	pH 5.6
Covered Plots			
Natural Inoculum	16.7	20.8	66.7
Artificial Inoculum	22.2	71.4	85.7
Uncovered Plots	No lime	Low lime	High lime
Natural Inoculum	13.6	24.1	44.4
Artificial Inoculum	100	96	90.9

AVERAGE NUMBER OF SPORES COLLECTED PER SLIDE AS RELATED TO AMOUNT OF RAIN, pH OF RAIN, RELATIVE HUMIDITY, AND INFECTION OF POTTED SEEDLINGS EXPOSED TO THESE CONDITIONS.

Date	Average # of Spores/Slide		Amount of Rain Inches[a]	pH of Rain	Hours of 100% RH/Week		Infection of Seedlings Site 2[b]
	Site 1	Site 2			Total	Before 12 AM	
May 14-21	316	50	.21	3.5	69	12	none
May 21-18	240	219	.82	3.4	118	60	2/4
May 28-June 4	6	10	.11	4.3	80	20	0
June 4-11	94	13	.53	3.3	124	66	0
June 11-18	1	-[c]	.02	-	62	10	0
June 18-25	2	2	.09	-	86	34	0
July 2- 9	14	7	.23	4.1	80	20	2/5
Aug 13-20	28	18	.80	4.0	94	38	
Aug 20-Nov 8	-	-	-	-	-	-	4/9

[a] Data from the New York Department of Environmental Conservation

[b] Site 1 had one infected seedling during the August 20-November 8 period.

[c] Missing data

Mr. SCHEUER. Thank you very much, Dr. Raynal. I will defer my questions and yield to Mr. Carney.

Mr. CARNEY. Doctor, limiting the sensitivity of soil's detrimental effects of acid rains, would it not be the leaching——

Dr. RAYNAL. You are asking about the application of lime to our unmanaged forest soils, and the question is whether that will slow down the process of nutrient leaching?

Mr. CARNEY. Right.

Dr. RAYNAL. That is very difficult to tell. We need some research in that area. One of the things that liming does do is provide additional quantities of some of these important nutrient bases, such as calcium, and magnesium. It does not, however, slow down, apparently, the movement of sulfates through these forest soils. Sulfate is an important chemical species which attracts the positively charged nutrient bases and remove them from the tree-rooting zone. So we are talking about adding them at the top and still removing them. It is a complicated matter.

Mr. CARNEY. It was stressed here this morning that we should look for the cheaper—you might want to use that word—forms of addressing this problem now, rather than the most capital-intense solution, while the scientific community can continue to do research and come up with firm, conclusive answers.

Now, people say that liming of the forests might fall into that category; that it is a cost-effective method to enhance forest production as compared to drastic capital-intensive programs at the source of solution.

Would you agree with that as being a cost-effective method now? Will we get more conclusive evidence?

Dr. RAYNAL. Possibly, but I would have serious questions about that, simply because the liming that has been done has been of surface waters, themselves, or of the watersheds immediately surrounding aquatic systems thought to be very sensitive to acidification. The application of large quantities of lime to the immense acreages of forest lands in New York State represents a tremendously expensive undertaking. I believe it would be premature at this stage to recommend such a plan. What we need to do is to undertake some studies so we understand the full consequence of liming.

Mr. CARNEY. Thank you very much.

Mr. GREGG. Are you familiar with this Canadian study that concluded that, white pine in Canada, was being affected negatively by SO_2?

Dr. RAYNAL. I am not familiar specifically with the study you point out. I am familiar with the sensitivity of white pine to various air pollutants, and it responds under certain circumstances to acidic precipitation and acid deposition.

Mr. GREGG. Are we affecting the lifetime of our white pine, the source for most of our commercial products? Does acid rain affect the oak and other species that are our own commercial trees?

Dr. RAYNAL. Congressman Gregg, that is an immensely complicated question. You are asking what deposition of acidifying substances affect a variety of differentially-sensitive species at various life cycle stages from seed germination to maturity and reproduction and does it affect those species equally under all circumstances where the plants grow.

I would point out, however, that some studies, including those of white pine, the species that you asked about specifically, have indicated that in contrast to what Canadians may be pointing out in the report that you mention, white pine under certain circumstances in the last 15 years or so has shown an increase in growth through the Adirondack region on certain sites.

Mr. **Gregg.** I take it it is your position, then, that you cannot at this time evaluate whether or not acid rain is affecting the commercial forest industry?

Dr. **Raynal.** At this time, I would suggest there is the potential for forests to be affected directly and indirectly, but, yes, I would concur with your summarization, but, to be very specific about a particular species and the effect on the forest industry would be premature at this time.

Mr. **Mitchell.** I guess you answered my questions. I didn't hear much of your testimony. I apologize for that. I had something else to do. However, in Canada, we learned from some studies they have made that acid rain slows down forest growth by about 4 percent a year. You would totally disagree with that, as a broad observation?

Dr. **Raynal.** As a broad observation, I would question that. I would want to see the data base on which those conclusions were made. I would not deny under certain circumstances species that are important in the Canadian forest industry may be detrimentally impacted by acid precipitation. It is certainly possible.

Mr. **Mitchell.** I think you are tying it in with the economic impact, the fact that the forest is one of their big industries, and they thought that acid rain retarded growth about 4 percent a year.

You wouldn't recommend it as an argument for those of us who want to do something about acid rain, the fact that in your eyes, at this time, acid precipitation can't be shown to reduce forest growth?

Dr. **Raynal.** It cannot be shown. Let me point out, however, a serious problem that forest ecologists and foresters in New York State are currently dealing with, and that is the die-back of red spruce, a commercially important species in the forests of New York State. Red spruce is in a serious state of decline. Not only in New York State and the Adirondack region, but in the Northeast, in general. The hypothesis is that acid precipitation and the deposition of acidifying substance are the factors that are responsible for that decline. Some preliminary information from several research projects suggest we ought to be concerned about that kind of problem. To address the problem intelligently, we are going to have to conduct correlational and experimental studies which show cause-and-effect relationships and determine the extent to which forest tree growth is declining because of acid precipitation.

Mr. **Mitchell.** You have in several instances suggested you would like to make more studies. Is the funding readily available for the studies you feel we need? How much do you need? How can the Federal Government help?

Dr. RAYNAL. I would comment that while the observation has been made that New York State may be receiving as much as 20 percent of the dollars set aside by the Federal Government for research in the area, that a large part of those moneys is probably going to Federal laboratories that are in New York State and not to New York State, per se. That is to say, that the research organizations and universities in New York State are not receiving large quantities of research dollars.

Mr. CARNEY. Doctor, it has been said that 20 percent of Federal dollars come into New York State for research. As I said, we are taking a national average on that, and at universities as well. We are trying to find out how much more money we do need.

Mr. MITCHELL. What do you need to do a good job, to make the studies that you have mentioned?

Dr. RAYNAL. Well, that is a very difficult question to answer.

Mr. MITCHELL. I am trying to ask you an easy question, and I can't seem to do that.

Dr. RAYNAL. Let me point out that Peter Lanahan, who was on the program this morning, indicated that a team of scientists and concerned officials from the State agencies will be convening next month to discuss just that issue, in order to arrive at some consensus as to what a recognized dollar might be based on. Without totally side-stepping the question, I would say we have to collectively address all of the needs. But there needs to be a better way of channeling dollars through the public and private universities.

Mr. MITCHELL. Would you agree with an answer to this question: You need a lot more than you have right now?

Dr. RAYNAL. Absolutely.

Mr. CARNEY [presiding]. Thank you, Dr. Raynal.

Our next witness will be Dr. Singer. Dr. Singer is a professor of biology at Colgate University, in Hamilton, N.Y.

Dr. Raynal, we appreciate your appearance.

Dr. SINGER. I am as cold and hungry as everybody else. I will try to keep my remarks brief.

The effects of acidic deposition on aquatic habitats vary considerably from one body of water to another. However, a few generalizations can be made. The lakes which are affected are typically small lakes, less than a few hundred acres in surface area at elevations greater than 2,000 feet. They have large expanses of exposed bedrock and very small watersheds.

As a lake becomes more and more acidic, several biological effects become apparent. Although the lay public generally considers the loss of fish populations to be the principal effect of deposition, fish losses are really one of the last consequences of acidic precipitation. The biological community shows severe alterations below pH values of six, and it takes at least another tenfold increase in acidity to below pH five for alterations of fish communities to appear.

Most noticeable is a mat of algae and fungi which covers the bottom and any exposed detritus. This mat takes the appearance of a thick carpet and is firm enough to be lifted and torn by hand. The aquatic plant community is restricted to very few tolerant species. Beneath this mat is an expansive accumulation of undecomposed organic material such as leaves, sticks, and decaying aquatic plants. Bacterial decomposition, which is the normal means of restoring nutrients to the water column, is inhibited.

The normal bottom-dwelling community of animals is severely restricted in numbers and diversity. Many common bottom-dwelling insects such as mayflies are eliminated. There is some variation between lakes with respect to the specific types of insects which are found, but one obvious generalization is a shift from detritus-feeding insects to carnivorous insects.

Concomitant with this change is a loss of fish populations. The role of fish as a predator on plankton, and bottom-dwelling insects is probably the mechanism by which predatory insects flourish. The sensitivity of fish has been shown to be greatest during the egg and fry stages. Most game fish are in these stages in the early spring when acidic deposition from snow melting is greatest. Hence, one-time grab-samples of water in the summer may not truly measure the potential for damage on an annual basis.

Fish feed primarily by visual cues whereas insect predators feed by tactile and chemical cues. When fish are lost, the plankton community shifts toward larger pigmented crustacean zooplankters which are more efficient grazers on algae. It is believed that a combination of the reduction in microbal decomposition and increased grazing by zooplankton are responsible for bringing about the striking clarity of many acid lakes. The visibility in some of these acid lakes rivals that of the clearest waters on Earth. From the surface, many of these acid lakes are beautiful places; but beneath the surface is an environment which is chemically hostile to fish and possibly unsafe for human consumption. The actual mechanism by which fish are eliminated is complicated.

Along with an increase in the hydrogen-ion concentration with acidification is the mobilization of metals which are insoluble at more neutral pH values. Metals such as iron and aluminum are very common in soils but normally remain in the soils as minerals. As acid rain percolates through the soils, the high acidity dissolves the metals in the watershed and carries them into the water.

In many documented cases, metal concentrations markedly increase in acidified lakes and streams. It has been demonstrated in the laboratory and in the field that the causal mechanism of death to game fish is high aluminum concentrations which destroy the membrane surfaces of the gills and damage the ability of the fish to regulate its internal salt concentration. Aluminum concentrations higher than 0.2 milligrams per liter are commonly reported in acidified lakes.

It is not yet clear how other toxic metals, such as mercury—which can be carried downwind from sources deposited on the ground and re-emitted to the atmosphere—affect the biota of North American lakes, but toxic accumulation of mercury has been demonstrated in Swedish lakes.

Surprisingly few intensive studies have been performed in the United States, and differences between lakes have provided fertile ground for arguments about the expanse of impact of acidic deposition. Lakes which are very near each other have undergone different alterations which confuses the importance of airborne deposition to this process.

It must be understood that effects of acidic deposition can be ameliorated by naturally occurring limestone in the watershed which has a spotty distribution in the Adirondacks. Natural nutrient levels which also vary between lakes will affect the outcome of deposition as well. Areas outside of the Adirondacks such as parts of the Catskills, Northern Minnesota, and Wisconsin and areas of the Rocky Mountains are also undergoing acidification, and have received even less study. Many of our conclusions are based on comparisons with the more extensive research which has been done in Scandinavia and Canada and may not be completely applicable to the U.S. problems.

Attempts at neutralizing lakes which have undergone acidification by liming have only been marginally successful. The long-term prospects for maintaining good fisheries in artificially-restored lakes are dismal.

The costs of this sort of treatment are very high, and it is still unclear how well it works. Additionally, rapid increase in pH brought about by artificial liming can actually increase the toxicity of aluminum which has already been brought into the watershed. Although liming may work, it is at best expensive, difficult to rationally set up a program and forces a long-term commitment to continued applications.

[The prepared statement of Dr. Singer follows:]

STATEMENT OF DR. ROBERT SINGER

DEPARTMENT OF [illegible]OLOGY
COLGATE UNIVERSITY

Presented at the Acid Precipitation Field Hearing
Committee on Science and Technology
U.S. House of Representatives
Lake Placid, N.Y. September 18, 1981

The effects of acidic deposition on aquatic habitats vary considerably from one body of water to another. However, a few generalizations can be made. The eastern US lakes which are affected are typically small lakes, less than a few hundred acres in surface area at elevations greater than 2,000 feet. They have large expanses of exposed bedrock and very small watershed.

As a lake becomes more and more acidic, several biological effects become apparent. Although the lay public generally considers the loss of fish populations to be the principal effect of deposition, fish losses are really one of the last consequences of acid precipitation. The biological community shows severe alterations below pH values of 6 and it takes at least another tenfold increase in acidity to below pH 5 for alterations of fish communities to appear.

Most noticeable is a mat of algae and fungi which covers the bottom and any exposed detritus. This mat takes the appearance of a thick carpet and is firm enough to be lifted and torn by hand. The aquatic plant community is restricted to very few tolerant species. Beneath this mat is an expansive accumulation of undecomposed organic material such as leaves, sticks, and decaying aquatic plants. Bacterial decomposition, which is the normal means of restoring nutrients to the water column, is inhibited.

The normal bottom-dwelling community of animals is severely restricted in numbers and diversity. Many common bottom-dwelling insects such as mayflies are eliminated. There is some variation between lakes with respect to the specific types of insects which are found, but one obvious generalization is a shift from detritus-feeding insects to carnivorous insects.

Concomitant with this change is a loss of fish populations. Fish act as predators on plankton and bottom-dwelling insects and the elimination of fish is probably the mechanism by which predatory insects flourish in acid lakes. These lakes are not "dead," they just lack fish. The sensitivity of fish has been shown to be greatest during the egg and fry stages. Most game fish are in these stages in the early spring when acidic deposition from snowmelt is greatest. Hence, one time grab-samples of water in the summer may not truly measure the potential for damage on an annual basis.

Fish feed primarily by visual cues whereas insect predators feed by tactile and chemical cues. When fish are lost, the plankton community shifts towards larger pigmented crustacean zooplankters which are more efficient grazers on algae. It is believed that a combination of the reduction in microbial decomposition and increased grazing by zooplankton are responsible for bringing about the striking clarity of many acid lakes. The visibility in some of these acid lakes rivals that of the clearest waters on earth. From the surface, many of these acid lakes are beautiful places; but beneath the surface is an environment which is chemically hostile to fish and possibly unsafe for human consumption.

The actual mechanism by which fish are eliminated is complicated. Along with an increase in the hydrogen-ion concentration with acidification is the mobilization of metals which are insoluble at some neutral pH values. Metals such as iron and aluminum are very common in soils but normally remain in the soils as minerals. As acid rain percolates through the soils the high acidity dissolves the metals in the watershed and carries them into the water.

In many documented cases, metal concentrations markedly increase in acidified lakes and streams. It has been demonstrated in the laboratory and in the field that the mechanism of death to game fish is high aluminum concentrations which destroy the membrane surfaces of the gills and damage the ability of the fish to regulate its internal salt concentration. Aluminum concentrations higher than 0.2 milligrams per liter are commonly reported in acidified lakes. It is not yet clear how other toxic metals such as mercury (which can be carried downwind from sources deposited on the ground and reemitted to the atmosphere) affect the biota of North American lakes, but toxic accumulations or mercury have been demonstrated in Swedish lakes.

Surprisingly few intensive studies have been performed in the United States and differences between lakes have provided fertile ground for arguments about the expanse of impact of acidic deposition. Lakes which are very near each other have undergone different alterations, which confuses the importance of airborne deposition to this process. It must be understood that effects of acidic deposition can be ameliorated by naturally occurring limestone in the watershed, which has a spotty distribution in the Adirondacks. Natural nutrient levels, which also vary between lakes, will effect the outcome of deposition as well. Areas outside of the Adirondacks, such as parts of the Catskills, Northern Minnesota, Florida, and Wisconsin and areas of the Rocky Mountains are also undergoing acidification, and have received even less study. Many of our conclusions are based on comparisons with the more extensive research which has been done in Scandinavia and Canada and may not be completely applicable to the U.S. problems. Of critical importance is the determination of the number of lakes, which are on the brink of becoming acidic. Once this acidification begins, it proceeds very rapidly. We can't predict now if we stand to lose an additional 20 lakes, 200 lakes, or 1000 lakes.

Attempts at neutralizing lakes which have undergone acidification by liming have only been marginally successful. The long-term prospects for maintaining good fisheries in artifically restored lakes are dismal. The costs of this sort of treatment are very high and it is still unclear how well it works. Additionally, rapid increase in pH brought about by artificial liming can actually increase the toxicity of aluminum which has already been brought into the watershed. Although liming may work, it is at best expensive, difficult to rationally set up a program and forces a long-term commitment to cortinued applications.

I urge this Committee to support research on the effects of acidic deposition, cautious research about restoration attempts, and to support legislation which will reduce emissions and prevent further environmental degradations. I suggest using Norway's SNSF Project, a super agency which directed that country's excellent research program as a model to avoid research now being duplicated in universities, by the State of New York, and the Electric Power Research Institute.

Mr. **Carney**. Mr. Sensenbrenner?

Mr. **Sensenbrenner**. No questions.

Mr. **Carney**. Mr. Gregg?

Mr. **Gregg**. I have heard a number of complaints about liming. Is there any other process but liming that would address the subject on the local level compared to addressing it at the emitting level?

Dr. **Singer**. To the best of my knowledge, liming is the most cost-effective mechanism of restoring an acidified lake. There are different forms of lime. They come at different costs, and local availability varies. By liming, I am talking in the generic sense of increasing pH by throwing acid-neutralizing rocks in the watershed or in the lake.

Mr. **Gregg**. How about lakes which haven't entered the dead status yet?

Dr. **Singer**. Sort of a prophylactic treatment. We don't really know how many lakes are on the verge. We don't know which lakes, where they are, and how many there are that are on the verge of becoming acidic. You can't apply lime to all the 4,000 lakes in New York State, and I think it is unreasonable to say let's just lime the whole State.

Mr. **Gregg**. "If it ain't broke, don't fix it."

Dr. **Singer**. I think that is a misconception the public has. There are acid lakes, but there are some lakes that are not going to become acidified. Saranac Lake, Lake George, Long Lake, Lake Champlain, the big lower-elevation lakes which have perhaps the greatest recreational potential in this State, are not likely to become acidic for the next few hundred or a thousand years. The buffering capacity in the watershed is sufficient to neutralize any reasonable amount of acid conditions.

Mr. **Scheuer**. In other words, those 200 lakes are mostly the smaller lakes and from the point of view of recreational resources, perhaps they are lakes of lesser importance.

Dr. **Singer**. They are smaller lakes.

Mr. **Scheuer**. The lakes you just ticked off are the lakes that come to mind when one thinks of the Adirondacks. The lakes that provide the major recreational sources are not being threatened. While there are lakes being threatened, they are of less interest to the economy of the State?

Dr. **Singer**. I can't address where the dollars are spent—whether or not more are spent on the larger lakes or more spent on the numerous smaller lakes—but I would agree that these larger lakes are not threatened.

Mr. **Carney**. Mr. Mitchell?

Mr. **Mitchell**. Thank you, Mr. Chairman. Just an observation. People have noticed the acid rain problem affects the fish population. That is something a layman can understand. We are not familiar with all the other types of life in a lake, but we have talked to friends who have fished the lakes for 20 years and used to catch fish and now they don't catch any.

You mentioned lakes on the brink of becoming acidic. So far as I know, the study hasn't begun to become complete. They have studied 849 lakes and they have over 2,000 lakes and ponds to go. Based on the study of 800, they feel 20 or 30 percent might be dead. They just haven't gotten to them. The State hasn't come up with the money to study these lakes.

Dr. **SINGER**. You may not realize it, the New York State report was a survey done with grab samples from a helicopter, one time in each lake, and there are problems with that report that the authors will admit. Even of those lakes that have been studied, they haven't been studied definitively. I have gone to some of those same lakes and got very disparate results.

Mr. **MITCHELL**. Can't you get different acidic readings whether it has rained or not, or whether it is in the spring, when the snow has just melted?

Dr. **SINGER**. Exactly.

Mr. **MITCHELL**. You are not going to know until you can make a conclusive study of 3,000 lakes. None of us know what the problem is, really, until you make the analysis.

We were talking to Mr. Fink about this, the fact that the State apparently is not coming up with enough money to complete the study rapidly. Someone in the department of environmental conservation informed me that with $340,000 for 3 years, they could do a good job, but with the present level of funding, it will take them 20 years, which is way too late.

Neutralizing lakes using lime: I am just beginning to hear how they do that. I understand sometimes they dump tons of limestone in a lake to raise the pH. You mention there was one negative effect, the toxicity of aluminum. Are there any other negative effects, the negative effects of dumping tons of limestone in a lake? Does it do anything to the bottom? Are there any other negative effects besides the change of pH?

Dr. **SINGER**. I am not an expert on restoration, but from what I understand from colleagues, we really don't know what is going on when we lime a lake. Typically the lime is applied on the ice surface in the wintertime, and what you can end up doing is produce dramatic swings in pH in the lake, and the effects of that at least on fish population are very unclear.

The liming of a lake can bring about rapid fertilization of the lake by mobilizing nutrients that are otherwise incapacitated, and the effects of that have been studied on other angles. Basically, scientists all seem to speak the same. We say we don't know.

Mr. **MITCHELL**. Thank you, Mr. Chairman.

Mr. **CARNEY**. Mr. Martin?

Mr. **MARTIN**. Doctor, as far as the side effects of liming is concerned, has there been any evidence or research done in places where they have done liming as to the effects of poisons from aluminum, and so forth?

Dr. **SINGER**. There have been field and laboratory studies done on artificially limed lakes, where the rapid raising of the pH has brought about increases in metal concentration to toxic levels. As you lime a lake, and you throw fish in, it could be worse than if you didn't do anything—if you do it in that sequence.

Mr. **MITCHELL**. It could be. It doesn't necessarily have to be.

Dr. **SINGER**. Yes.

Mr. **GREGG**. I just heard from people in my area about the Hubbard Brook study. I guess it was done under Dr. Aiken Likens in Cornell. He was coming out with a report, and I just wondered if you had heard anything about it—anything about it which dealt with the problems of nitrates versus sulfates.

Dr. **Singer**. In the United States, nitrate is a bigger problem than it is in Europe.

Mr. **Gregg**. Is it a bigger problem in the Northeast? Are nitrates a bigger problem?

Dr. **Jacobson**. What you are referring to is the fact that in the last several decades there have been greater increases in emissions of nitrogen oxides than in emissions of sulfur oxides, and in parallel with that, there is some evidence that the proportion of nitrate in rain has increased relative to sulfate, which would be a reasonable result of increased emissions of nitrate. However, nitrates still have not surpassed sulfate in their contribution to the acidity of rain, although their relative proportions have increased.

Mr. **Gregg**. In the Northeast, which is the most serious, nitrate or sulfate rain?

Dr. **Jacobson**. There is more sulfate than nitrate in rain on a chemical basis, but nitrates are increasing more rapidly than sulfates. Sulfates are not actively increasing.

Mr. **Carney**. Thank you very much, Mr. Gregg.

We have asked you to get into an open dialogue among yourselves, to say whatever you would like that you have not had an opportunity to talk about. We have about 15 minutes.

Dr. **Jacobson**. I have a short question for Dr. Singer.

Could you try and answer the question of whether lakes that are now acidic, a pH less than five, would be restored—that is to say, have significant decreases in acidity within a relatively short period of time—if emissions of pollutants were to decrease? Would an acidified lake become restored by natural processes within a relatively short period of time?

Dr. **Singer**. He knows he is not going to get a straight answer to a simple question.

I will try to give a straight answer. I would say for the lakes that I have studied, yes, I think they would be restored. In the severely acidic lakes, the lakes with pH's around 4 or 5, 4 to 6, or even less than that, I have sampled both the water column and the sediments, and almost universally the pH of the sediments are higher in the water, and that tells me that the acidity is coming from above. It is trying to be buffered, trying to be neutralized by the sediments, but the continued influx of acidity the sediments can't handle because of their low neutralizing capacities, but given some time and given half a chance, there is still some buffering capacity left. There are other buffers besides carbonates that are active in these systems but that work slowly.

Dr. **Raynal**. I have a question for Dr. Mohnen. We are talking largely about regional problems of acid precipitation and average values. I would like to ask, if we go back and look at individual storms that deliver highly acidic rain, what can we conclude about those individual events that might be useful in assessing the problem on a local basis, and might be of help to effects biologists who might be interested in addressing this problem?

Dr. **Mohnen**. I think so far all of you, including all of the panel here, have talked about averages. You will find that one has to talk also about rates of delivery.

I do not want to complicate the issue, but obviously when you have a massive hurricane dumping in a very short period of time "clean" water on the watershed, nevertheless if that water has a pH of 4.4 and 4.5, then the overall deposition of acidity, in a very short period of time, is and can be as severe on the ecosystem as if you have a very polluted rain that allegedly came right straight from the Midwest, dumping the same amount over a shorter period of time with much less rain. The question of doses has to be addressed by the effects people. They are beginning to recognize that a spring melt in New York State Adirondack Park probably is the biggest insult you can do to the aquatic system.

Now, it so happens that our snow that accumulates in the Adirondacks comes from air masses that are either "Great Lakes," or "northern". We can show you that. So, begin to be more sophisticated in the approach to the problem. Appreciate the tremendous problems that still lie ahead of us.

On the average, we could do something, but is the damage done more severely by an individual event of short duration, the rainfall, or the accumulation of snow resulting in a quick snow melt in the wintertime? These are the challenging questions and Dr. Raynal has addressed them properly. I guess you should keep it in mind as you oversimplify the solution by cutting something "on the average" and hoping "on the average" it will do good at the receptor side.

Mr. CARNEY. Are there further questions?

Mr. SCHEUER. I want to thank the witnesses for an absolutely marvelous performance. All of you have been thoughtful and provocative, and we are very grateful to you.

We will adjourn the meeting until 2 o'clock.

AFTERNOON SESSION

Mr. SCHEUER. This afternoon's schedule of the hearing on acid rain of the Subcommittee of the Science and Technology Committee on Natural Resources, Agriculture Research and Environment will commence.

We have two panels this afternoon. I will ask the four members of the first panel to proceed to the witness table. Dr. Ann LaBastille, West of Winds Publications, Big Moose, N.Y. She is a member of the Adirondack Park Agency and an ecological consultant.

This fall, incidentally, the November issue of the National Geographic magazine will publish an article by Ms. LaBastille on acid rain. (See appendix, p. 672.)

I heard Ms. LaBastille testify before Senator Moynihan's committee in Albany in July and she gave a superb testimony.

Bill Roden operates a Trout Lake Club, a resort in the Adirondacks, and writes a newspaper column on fishing and wildlife.

Sue Dyer, executive director of the Saranac Lake Chamber of Commerce.

Dennis Conroy of the Upper Hudson Environmental Action Committee. And that accounts for the first panel.

What we are going to do is limit each of you to 5 minutes and then we will have approximately 10 minutes to ask you questions.

At the end we will take another 10 minutes or so to see if there is any cross-fertilization that can take place between and amongst you.

STATEMENTS OF DR. ANN LaBASTILLE, WEST OF WINDS PUBLICATION, BIG MOOSE, N.Y.; WILLIAM M. RODEN, TROUT LAKE CLUB, DIAMOND POINT, N.Y.; JANET SUE DYER, EXECUTIVE DIRECTOR, SARANAC LAKE CHAMBER OF COMMERCE, SARANAC LAKE, N.Y., AND DENNIS CONROY, UPPER HUDSON ENVIRONMENTAL ACTION COMMITTEE, WEAVERTOWN, N.Y.

Mr. **SCHEUER**. First, Dr. LaBastille. The testimony of all witnesses will be printed in the record. Give us the highlights of your testimony and then we will take another 8 or 10 minutes to ask you some questions. Please proceed.

Dr. **LABASTILLE**. I would like to address the impacts of atmospheric pollution, both the ambient forms and wet deposition, on the Adironack Park, a downwind receptor to pollution sources in the Midwest.

I shall qualify my remarks by noting that these impacts are the cumulative effect on ecosystems of several years of atmospheric pollution which has been largely invisible, gradual and insidious.

Also, that it is impossible to draw a line between SO_2, SO_X, NO_X, total suspended particles [TSP], traces of heavy metals, dry deposition, and wet precipitation because the process from emissions to fallout is a continuous one of transformation and transportation, and all these forms of atmospheric pollution are present in the Adirondacks.

My background and reasons for coming today are the following: I am a concerned citizen and scientist [ecologist] who has lived in the Adirondacks for almost 25 years and seen my lake go from a prime trout fishing spot to one devoid of fish.

I am also a Commissioner for the Adirondack Park Agency, a State land use planning agency responsible for the 6-million-acre Adirondack Park.

This area is the largest State park in the USA, and one in which we could fit five National Parks: say Yellowstone, Grand Tetons, Olympic, Smokey Mountains, and Everglades within the Blue Line which defines the Adirondack Park.

In addition, I have been fortunate to be the writer of an acid rain article for National Geographic this past year and half which will appear in November, 1981. Thanks to the magazine's generosity, I have traveled widely through the United States, Scandinavia, Switzerland and Hawaii, meeting scientists and attending conferences dealing with acid deposition.

This has given me a broader view of the phenomena, taking it from a regional perspective to a global exposure.

Just a word about the Adirondacks themselves. It is the first high land mass after the midwestern plains, with elevations to 5,000 feet. They hold roughly 3,000 lakes, 30,000 miles of rivers and streams, and sensitive soils which are naturally thin and acidic.

There is very little buffering capacity in either soils or waters. We have very little industry, or agriculture other than logging or some mining. The mountains, are a prime tourist area, and approximately 9 million visitors come each year.

It is interesting to note that the Adirondack Park was formed by a New York State constitutional law in 1892, and in 1894 the Fourteenth Amendment gave lasting protection to the State lands within this park with its "forever wild" provision.

There are four major areas of impact of atmospheric deposition, all of which are ecologically linked together. They are: Aquatic ecosystems, air quality, forests and soils, and ground/surface waters.

Aquatic ecosystems show the greatest impacts in that almost 300 lakes and ponds in the Adirondacks are now fishless, and an equal amount threatened. Investigations have been carried out by New York State's Department of Environmental Conservation.

In addition to fish, other aquatic life show changes due to acidic deposition. Aquatic insects either die off, or thrive when relieved of fish predation pressures, depending on their sensitivity to acidity. All plankton is affected and decreases to the point where a lake becomes very clear and often bluish in color.

Wildlife diminishes as fish-eating species such as mink, otter, herons, and certrain ducks are forced to move to new habitats or starve.

In general, Adirondack lakes affected by atmospheric pollution and deposition are less productive, useful, and fun to humans. Real estate values, tourism, and outdoor recreation suffer.

The Adirondack Park Agency estimated in 1975 that there was a $1.5 million loss per year in sport fishing due to acid rain.

Air quality and clarity in the mountains has diminished. Early reports by surveyors such as Verplanck Colvin, and explorers in the mid- to late-1800's tell of sparkling bright days with magnificent vistas and scenes.

However, the last two to three decades have brought a decrease in clarity and episodes of dry, hazy weather with visibility much curtailed.

The various measurements made by atmospheric research scientists indicate that atmospheric pollution in this area, a downwind receptor to the Midwest, is responsible, includng SO_2, SO_X, TSP, et cetera.

Two atmospheric scientists, Ray Falconer and Dr. Vincent Schaeffer, have noted from personal observations that in the past 15 years summertime visibility has worsened and is interfering with the magnificent views.

In the Adirondacks, we have little cultural heritage in the form of famous old churches, monuments, or stone statuary or buildings which can be corroded by acid rain.

However, our heritage is our natural beauty. This is partly what brings those 9 million tourists a year.

If we were a national park, our air quality would be classified as class I; and indeed, our 1.1 million acres of wilderness should be equivalent to this rating.

The present pollution of our visibility is harming our heritage, spoiling tourism, and surely lowering the quality of photography done here.

Forest ecosystems, and their supporting soils [substrate], are another arena feeling the impacts of atmospheric pollution and deposition.

As yet, there is no conclusive proof in nature that injury occurs; however, in growth chambers, field plots and lab tests with simulated air pollution [SO_2, et cetera] and precipitation [acid rain], definite damage has been shown.

Some effects are: injury to leaves and fine root hairs, lowering of disease and insect resistance, decrease in soil organisms responsible for organic breakdown and decay, and a slowdown in nutrient cycling of the ecosystem.

We are suspicious that these same effects are taking place in Adirondack forests and soils, but it will take more study and proof. Trees take a long time to show stress and damage from pollution in nature.

The acidification of ground and surface water in the western Adirondacks is a growing problem, much the same as in western Sweden.

Two years ago, I guided Dr. Wolfgang Fuhs, an environmental scientist from the New York State Department of Health, to a number of small municipal reservoirs, shallow wells, and natural springs. He sampled domestic water and found many homes with elevated levels of copper, lead, and aluminum.

Residents of certain hamlets in the western Adirondacks are complaining that their plumbing corrodes rapidly as acidified water leaches copper from the lines and lead from the solder. It is not unusual to replace metal plumbing lines every 5 to 7 years now days, whereas years ago they lasted decades.

In addition, those natural springs sampled showed high levels of copper and aluminum. Since these springs are back in the woods untouched by human hands, it appears that these heavy metals are being mobilized and transported from surrounding soils by acidic precipitation. Acidified drinking water could be a potential health problem over long periods.

As it is now, the Adirondack Park agency recommends to residents of these areas to allow their faucets to run for a few minutes each morning [or after any period of non-use] in order to flush heavy metals out of the lines.

These four areas of impact mentioned above have been occurring within the last three plus decades. Before that, and back to the ice age some 10,000 to 12,000 years ago, no such phenomenon took place.

Nature apparently had her own system of checks and balances which neutralized natural atmospheric pollution and acidic deposition. But now the environment is unbalanced. All the correlative evidence points to the cumulative effects of atmospheric pollution and deposition as producing serious ecological problems.

Thank you.

[The prepared statement of Dr. LaBastille follows:]

TESTIMONY BY DR. ANNE LABASTILLE, ECOLOGIST, SEPTEMBER 18, 1981

HEARING ON ACID RAIN AND THE CLEAN AIR ACT

I would like to address the impacts of atmospheric pollution, both the ambient forms and wet deposition, on the Adirondack Park, a downwind receptor to pollution sources in the Midwest. I shall qualify my remarks by noting that these impacts are the cumulative effect on ecosystems of several years of atmospheric pollution which has been largely invisible, gradual and insidious. Also, that it is impossible to draw a line between SO_2, SO_X, NO_X, total suspended particles (TSP), traces of heavy metals, dry deposition, and wet precipitation because the process from emissions to fallout is a continuous one of transformation and transportation, and all these forms of atmospheric pollution are present in the Adirondacks.

My background and reasons for coming today are the following: I am a concerned citizen and scientist (ecologist) who has lived in the Adirondacks for almost 25 years and seen my lake go from a prime trout fishing spot to one devoid of fish. I'm also a Commissioner for the Adirondack Park Agency, a state land use planning agency responsible for the 6-million-acre Adirondack Park. This area is the largest State park in the USA, and one in which we could fit five National Parks: say Yellowstone, Grand Tetons, Olympic, Smokey Mountains, and Everglades within the Blue Line which defines it. In addition, I've been fortunate to be the writer of an acid rain article for National Geographic this past year. Thanks to their generosity, I have traveled widely through the United States, Scandinavia, and Hawaii, Switzerland, meeting scientists and attending conferences dealing with acid deposition. This has given me a broader view of the phenomena, taking it from a regional perspective to a global exposure.

Just a word about the Adirondacks themselves. It is the first high land mass after the midwestern plains, with elevations to 5,000 feet. They hold roughly 3,000 lakes, 30,000 miles of rivers and streams, and sensitive soils which are naturally thin and acidic. There is very little buffering capacity in either soils or water a minimum of agriculture and industry. The mountains are a prime tourist area, and approximately nine millions visitors come each year. It is interesting to note that the Adirondack Park was formed by a New York State Constitutional law in 1892, and in 1894 the 14th Amendment gave lasting protection to the state lands within this Park with its "forever wild" provision.

There are four major areas of impact of atmospheric deposition, all of which are linked ecologically together. They are: aquatic ecosystems, air quality, forests and soils, and ground/surface waters.

Aquatic ecosystems show the greatest impacts in that almost 300 lakes and ponds in the Adirondacks are now fishless, and an equal amount threatened. Investigations have been carried out by New York State's Department of Environmental Conservation. In addition to fish, other aquatic life show changes due to acidic deposition. Aquatic insects either die off, or thrive when relieved of fish predation pressures, depending on their sensitivity to acidity. All plankton is affected and decreases to the point where a lake becomes very clear and often bluish in color. Wildlife diminishes as fish-eating species such as mink, otter, herons, and certain ducks are forced to move to new habitats or starve. In general, Adirondack lakes affected by atmospheric pollution and deposition are less productive, useful, and fun to humans. Real estate values, tourism, and outdoor recreation suffer. The Adirondack Park Agency estimated in 1975 that there is a $1.5 million loss per year due to sport fish decreases.

Air quality and clarity in the mountains has diminished. Early reports by surveyors such as Verplanck Colvin, and explorers in the mid- to late-1800's tell of sparkling bright days with magnificent vistas and scenes. However, the last two to three decades have brought a decrease in clarity and episodes of dry, hazy weather with visibility much curtailed. The various measurements made by atmospheric research scientists indicate that atmospheric pollution in this area, a downwind receptor to the midwest, is responsible, including SO_2, SO_X, TSP, etc. Two atomspheric scientists, Ray Falconer and Vincent Schaeffer, have noted from personal observations that in the past 15 years summertime visibility has worsened and is interfering with the magnificent views.

In the Adirondacks, we have little cultural heritage in the form of famous old churches, monuments, or stone buildings which can be corroded by acid rain. However, our heritage is our natural beauty. This is partly what brings those nine million tourists a year. If we were a National Park, our air quality would be classified as Class I; and inded, our 1.1 million acres of wilderness is equivalent to this rating.

The present pollution of our visibility is harming our natural heritage, spoiling tourism, photography and lowering the amount of enjoyment and recreation here.

Forest ecosystems, and their supporting soils (substrate), are another arena feeling the impacts of atmospheric pollution and deposition. As yet, there is no conclusive proof in nature that injury occurs; however, in growth chambers, field plots and lab tests with simulated air pollution (SO_2, etc.) and precipitation (acid rain), definite damage has been shown. Some effects are: injury to leaves and fine root hairs,[1] lowering of disease and insect resistance, decrease in soil organisms responsible for organic breakdown and decay, and a slowdown in nutrient cycling of the ecosystem. We are suspicious that these same effects are taking place in Adirondack forests and soils, but it will take more study and proof. Trees take time to show stress and damage due to pollution in nature, being long-lived and slow to respond.

The acidification of ground and surface water in the western Adirondacks is a growing problem, much the same as in western Sweden. Two years ago, I guided Dr. Wolfgang Fuhs, an environmental scientist from the New York State Department of Health, to a number of small municipal reservoirs, wells, and natural springs. He sampled domestic water and found most homes with elevated levels of copper, lead, and aluminum. Residents of certain hamlets in the western Adirondacks are complaining that their plumbing corrodes rapidly as acidified water leaches copper from the lines and lead from the solder. In addition, those natural springs sampled showed high levels of copper and aluminum. Since these springs are back in the woods untouched by human hands, these heavy metals are being mobilized and transported from surrounding soils by acidic precipitation. Acidified drinking water can be a potential health problem over long periods. As it is now, the Adirondack Park Agency recommends to residents of these areas to allow their faucets to run for a few minutes each morining (or after any period of non-use) in order to flush heavy metals out of the lines.

These four areas of impact mentioned above have been occurring within the last three decades. Before that, and back to the Ice Age some ten to twelve thousand years ago, no such phenomonon took place. Nature apparently had her own system of checks and balances which neutralized natural atmospheric pollution and acidic deposition. But now the environment is unbalanced. All the correlative evidence points to the cumulative effects of atmosheric pollution and deposition as producing serious ecological problems.

Thank you.

Mr. SCHEUER. That is very moving testimony.

I don't know how you include in any cost-benefit calculus the fact that you don't see ospreys anymore. To me it is part of the quality of our life. I find it offensive we will be turning over to our kids and our grandchildren that kind of a world and that degrade a national patrimony.

I will ask Dave Martin to take the chair.

Mr. MARTIN [presiding]. I will attempt to keep us to our schedule. I appreciate people staying within the confines of that.

I want to thank you, not only for your testimony here, but before Pat Moynihan as well. He praised you highly to me personally about the job you did.

Are there questions of the panel?

Mr. MITCHELL. In your travels throughout Europe, how serious is the condition of the lakes in Sweden? I have heard all kinds of stories. Are they mostly dead?

Dr. LABASTILLE. Yes. The situation in Scandinavia is far more severe than in northern Canada and the United States. Estimates msde at this time are 20,000 lakes either with no fish or on the verge of becoming fishless.

More importantly than that, in western Sweden, I went out with Dr. Hans Hultberg and went into a rural area where young children drinking well water on farms experienced diarrhea for the first 2 years of their life because of the high copper content in acidified groundwater.

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[1] Recent research in Germany indicates that as a result of acid rain in soil aluminum is released which is toxic to fine roots hairs, especially of beech and silver fir. This puts the trees in a highly stressed condition and lowers their survival.

Dialysis patients on kidney machines are not permitted to use water at home. They must go to a major hospital so they won't pick up high amounts of aluminum. There are many other human effects.

In fact, if you wash your hair in acidified well water in western Sweden, in some isolated areas, it will turn green.

Mr. MITCHELL. Has the scientific community gotten together with any unanimous recommendations for addressing the problem, or are they divided as our scientific community seems to be as to whether we should do anything at all?

Dr. LABASTILLE. I found both the Scandinavians, and most of the Europeans I spoke with in Switzerland, are very much more direct and straightforward in their approach. They feel the answer is control of emissions. As you know, there is a convention on air pollutants in the United Nations. I think there are 35 signatures by European and other countries. Hopefully, this will lead to some reduction in the emissions.

As a good case in point, Sweden, because it is the victim of north European countries, has already cleaned up its emissions by 50 percent. They feel within that country—and the same in Norway—they are only producing 5 percent domestically of their pollution. The other 95 percent is being dumped on them from the Netherlands, Germany, and so forth, in northern Europe.

Mr. MITCHELL. Is it your opinion, having traveled there and witnessed the situation, that we can learn from their example? Are they maybe 5 years ahead of us in destruction?

Dr. LABASTILLE. Easily and more than that.

Mr. MITCHELL. Can we look at what has happened there and maybe do something here to prevent that devastation?

Dr. LABASTILLE. I would say it would be extremely rewarding to go to Norway and Sweden and go out in the field with scientists and see the lakes, see their liming procedures, which are very advanced, their whole political awareness of this problem.

The Swedish Nature Conservancy has beautifully colored brochures talking about acid rain. They pass these out at their borders to tourists coming in in the summer, and elsewhere. Therefore, people arriving in Scandinavia see these crystal lakes with no fish in them, and they are really made aware of the problem and what can be done about it.

Mr. MITCHELL. You mention in your testimony that we have about 300 lakes affected in the Adirondacks. I hear all kinds of different numbers. I also have heard that the 300 lakes that are definitely affected are only part of an 800- or 900-lake study. Is that true? We haven't really inventoried all 3,000 lakes, I don't think. If it is that 300, what figure do you think it will be if we ever get this completed?

Dr. LABASTILLE. Mr. Martin H. Pfeiffer, lake acidification studies project leader, is here, who is the expert. Three hundred is a rough estimate out of 3,000 lakes in the Adirondacks. There is a much larger study of some 800 or 900. There is a larger program also being considered.

Mr. **Mitchell**. Mr. Chairman, could Mr. Pfeiffer respond?

STATEMENT OF MARTIN H. PFEIFFER, LAKE ACIDIFICATION STUDIES, PROJECT LEADER, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, RAY BROOK, N.Y.

Mr. **Pfeiffer**. In our subtitle of 849 Adirondack lakes and ponds documented in the acidity status report published in 1980, we discovered there 264 bodies of water with a summer surface pH below 5, which we consider critical for most forms of desirable fishlife.

This only represented less than a third of the available bodies of water in the Adirondack ecological zone, so if we simply make a mathematical extrapolation, we can certainly say it is possible there are at least 600 lakes that are critically acidified minimal, but the point is we have already studied most of the larger lakes, and the conclusion reached in our report is that the smaller lakes are the ones that are most vulnerable from a commonsense point of view; many of the remaining lakes, much beyond the mathematical expectation, will also be critically acidified because they are smaller, and we have studied the bulk of the larger ones.

One factor that enters in, however, and which is very well worth mentioning, is that we confess that the Adirondack region possesses numerous natural acidic bog-type ponds. These are primarily quite small, but they number certainly in the hundreds, possibly 500 to 600, and we have to consider this in respect to the problem of atmospheric acidification or pollution. These lakes were not viable habitats for fishlife, say, 50 years ago, but, again, fortunately, they are usually very small and the aggregate acreage does not amount to very much, but this is something that we have to consider and admit.

[The prepared statement of Mr. Pfeiffer follows:]

Written Statement Submitted at the House Science and Technology
Committee, Natural Resources, Agricultural Research and
Environmental Subcommittee Hearing on Acid Rain
September 18, 1981
Lake Placid, New York

Martin H. Pfeiffer
Lake Acidification Studies Project Leader
Department of Environmental Conservation
Ray Brook, New York

A somewhat controversial acid rain position statement has been published in the Potsdam Courier and Freeman Newspaper and is also scheduled for presentation at the September 18, 1981, Lake Placid Congressional Hearing. This testimony is to be presented by Dr. Harold Hughes who is serving as Vice President and Energy Committee Chairman of the Adirondack Association. In general, Dr. Hughes' statements seem to be in conflict with the Adirondack Association's resolution which he quotes at the beginning of his testimony. Also, his viewpoint differs significantly from D.E.C.'s position on this subject in terms of our desire to strengthen the Clean-Air Act to reduce sulfur emissions which are considered largely responsible for the acidification of many Adirondack ponds and lakes.

Thus, I have consulted with a number of acid rain experts who have furnished information to help refute some of Dr. Hughes' principle arguments. His interpretation of a Rensselaer Polytechnic Institute study authored by Arland H. Johannes, James N. Galloway and David E. Troutman, implies that since winter snow events in the Adirondacks are dominated by nitric acid, a reduction in sulfur emissions would have little effect on spring nitric acid infusions. In contacting Arland Johannes, one of the authors of this paper, I was informed that, on a molar basis, sulfuric acid input is still fairly significant in the winter, although it is very dominent under summer conditions.

A communication from Dr. Carl Schofield of Cornell University also indicated that Dr. Hughes' interpretation of the available data is incorrect. Dr. Schofield's opinion was based on data from Panther Lake (from Galloway, et al. 1980, Sandefjord Proceedings). The example provided illustrates the fact that neither dilution or increased nitrate would cause significant acidification if sulfate levels were reduced (a copy of Dr. Schofield's correspondence on this subject is enclosed).

Also, another informant, Philip Galvin of D.E.C.'s Division of Air Resources, indicated that there is growing evidence that sulfuric acid plays a larger role than nitric acid in mobilizing toxic metals, such as aluminum which, in itself, is extremely inimical to aquatic life.

Dr. Hughes also quotes the results of a Bell Telephone Laboratory study incriminating carbonyl sulfide as a major natural agent of atmospheric corrosion. The same may be said for his emphasis on dimethyl sulfide as an abundant natural precurser of sulfuric acid. Since the latter results from oceanic processes it is questionable if this source exerts a great deal of influence on the Adirondacks.

As a general repudiation to the suggestion that natural sources may actually account for a significant percentage of sulfur emissions in the Adirondacks, Philip Galvin has supplied me with an excerpt from a recent Washington State University report describing the importance of natural sulfur emissions in the "SURE region" (the Northeast and eastern Midwest). This study assessed the natural emissions of several sulfur compounds including carbonyl sulfide and dimethyl sulfide and concluded:

> "The annual anthropogenic emission of sulfur in the SURE area has been reported to be 1 x 107 MT. The calculated total biogenic sulfur flux, based upon our measurements, may then represent approximately 0.6% of the total atmospheric sulfur burden in the SURE study area. The SURE area is bounded on the south by extensive areas having a higher potential biogenic sulfur emission than the SURE area itself. Furthermore, the general clockwise air mass circulation from the Gulf northeastward through the Mississippi and Ohio River valleys toward New England will contribute to the biogenic fraction of the atmospheric sulfur burden of the SURE area. A conservative estimate of this Gulf Coast contribution might raise the estimated biogenic contribution to the total SURE area sulfur burden to a range of 1 to 2.5%".

The above data certainly help to refute Dr. Hughes' claim that natural emissions play a major role in contrast to manmade industrial emissions which are transported at high levels in the atmosphere from tall stacks. The installation of tall stacks and electrostatic precipitators, to reduce local smog problems, have resulted in the long distance transport from large sources to the west which are presently causing the acid ion deposition problems in the sensitive Adirondack area.

Another inconsistency in Dr. Hughes' statement relates to his comments on the effects of forest fires. First he states that forest fires contribute to the generation of carbonyl sulfide. Subsequently, he states that forest fires represent an acid neutralizing event. It is my belief that the initial effect of an active fire is to produce sulfur compounds which may be precursors to acids but the long-term effect of a forest fire is acid neutralizing due to the production of alkaline potash.

The comment on winter fish kills due to dissolved oxygen deficiencies under the ice cover in Wisconsin lakes certainly does not appear relevant to the subject under discussion. Also, the decline of fish populations in southern Scandanavia has been documented as a gradually accellerating phenomenon which was eventually correlated with increasing acidification.

In conclusion, I agree with Dr. Hughes' comment that the acid rain scenario may be oversimplified. Admittedly, the subject matter is very complex and while all the components of the problem are not completely understood, it is my conviction that we should follow the successful example of Japanese industry and reduce acid emissions as rapidly as possible. Strengthening the Clean Air Act will be a step in the right direction.

New York State College of Agriculture and Life Sciences
a Statutory College of the State University
Cornell University

Department of Natural Resources
Fernow Hall, Ithaca, N.Y. 14853

Fishery Science
Forest Science
Wildlife Science
Natural Resources
Resource Policy
and Planning

September 11, 1981

Mr. Martin Pfeiffer
N.Y.S.D.E.C.
Ray Brook, NY 12977

Dear Marty:

In your recent memo, you requested responses and clarification of some points raised by Dr. Hughes in his testimony to the House NR Subcommittee. I would like to particularly take issue with the statement made by Dr. Hughes that, "...reducing sulfur emissions will have little effect on these spring nitric acid infusions into Adirondack lakes." (pg. 3 of statement) His implication that nitric acid from melting snow (the HNO_3 could also come from soil nitrification and we don't yet know the relative contributions of each source) is the cause of acidification during the spring in Adirondack lakes and therefore, reducing sulfuric acid loadings would be ineffective in preventing episodic acidification is incorrect.

The enclosed figure (from Galloway, et al. 1980, Sandefjord Proceedings) clearly illustrates the causes of snow melt acidification. Loss of bicarbonate alkalinity, with resulting pH drops and increased Al concentrations, occurs whenever the equivalent sum of all strong acid anions (C_A) exceeds the equivalent sum of base forming cations (C_B). This can occur either as a result of dilution of C_B or an increase in C_A. It is obvious that both mechanisms operate to varying degrees in the three lakes illustrated. Dilution of C_B (relative to C_A) is most prevalent in Panther Lake, where neutral, ground water dominated base flow is replaced by acid, shallow interflow during snow melt. All three basins exhibit an increase in C_A during snow melt, which is due primarily to increased nitrate. The different responses of the Panther and Woods Lake basins are explained in the notes on the enclosed figure.

The effect of decreasing sulfate levels in Panther Lake on snow-melt pH and Al levels is illustrated in the table below:

Currently observed conditions

μeq/l

	C_B	C_A	SO_4	NO_3	Cl	Al*	pH*
Baseflow	320	150	120	20	10	.001	7.52
Snow-melt	160	200	120	75	5	20	4.70

C

Assuming a 50% SO_4 reduction

µeq/l

	C_B	C_A	SO_4	NO_3	Cl	Al*	pH*
Baseflow	320	90	60	20	10	.001	7.68
Snow-melt	160	140	60	75	5	.011	6.63

* pH and Al calculated from the following equation, assuming equilibrium with atmospheric CO_2 and amorphous $Al(OH)_3$:

$$H+ = C_A + HCO_3^- - C_B - Al^{+n}$$

I think it is obvious from the above that neither dilution or increased nitrate would cause significant acidification if sulfate levels were reduced. You can graphically illustrate the response by simply lowering the C_A and SO_4 lines on the enclosed figure until $C_B > C_A$. This is the amount of SO_4 reduction required to prevent acidification.

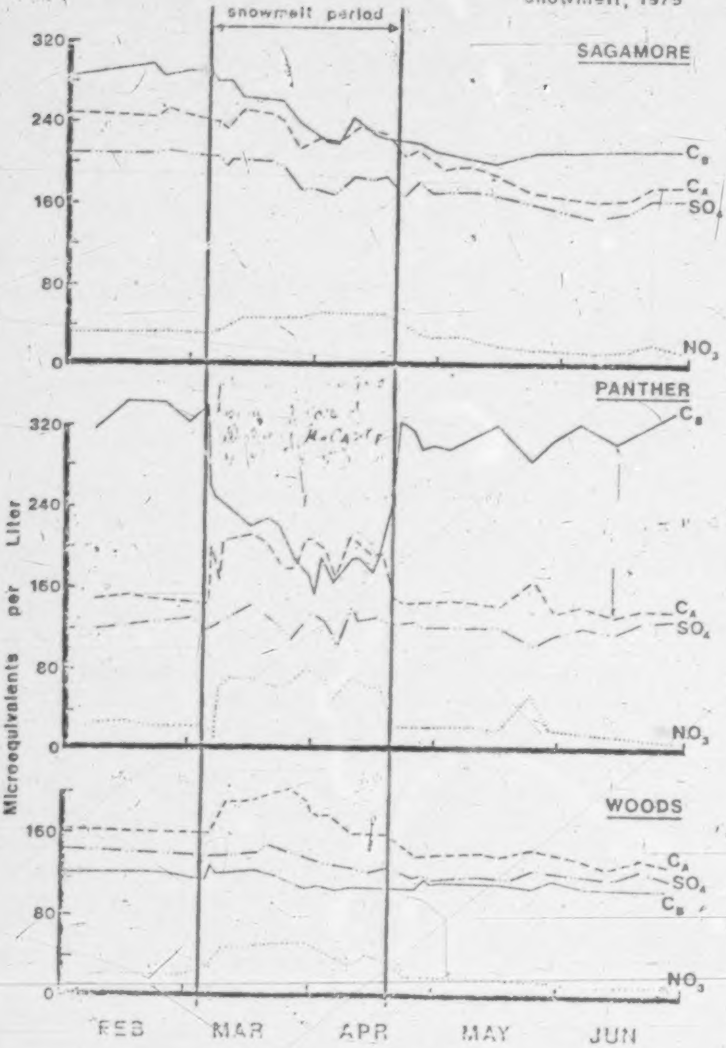
Sincerely yours,

Carl/cw

Carl L. Schofield
Senior Research Associate

CLS:cw

Fig. 2. Temporal Trends in Lake Composition: during snowmelt, 1979



C_B = [illegible]

C_A [illegible]

Mr. **MITCHELL.** Thank you, Mr. Pfeiffer.

Mr. **CARNEY.** Have you seen anywhere in your world travels a demonstrated program that has reduced acidity through acid rains, Dr. LaBastille?

It is obvious you have spent years studying this particular problem and traveling to where the problem has been demonstrated to be critical throughout the world. In your travels have you seen demonstrated a program that has reduced the amount of acid rain, where it was obvious there was a problem, or have we only seen throughout the globe an identification of the problem and no remedial action?

Dr. **LABASTILLE.** I have not been to Japan, but I understand in Japan they have had critical air pollution problems, and some acid rain. Through government control they have reduced up to 80 percent of their emissions, and I think at the same time they have had a substantial increase in electric power. It is obvious, there, you don't have to pollute.

I am not able to talk much more about that, because I haven't been there.

In the case of Sweden, you can't make a comparison because they are getting all the fall out from northern Europe. Yes, they have cleaned up their country, but they can't stop what is blowing in on the wind.

Mr. **CARNEY.** That would be similar to the Adirondack region. We are doing everything we can do here, but the consequence of our problem is related to what lies to the West. I haven't had an opportunity to go abroad and visit areas with the same problem.

I wondered if there are demonstrated programs that reduce the acidity content in the precipitation.

The reason I bring that question up; it is almost a follow up to the panel this morning of scientists where we are talking about the amount of acidity and the impact of reducing the point of pollution. It not necessarily will give you the reduction, where it ultimately winds up—where the problem ultimately winds up—and I was wondering if we have anything that we can reliably look to, to see just how much control is necessary, how much of a reduction is necessary to let Mother Nature come back and do the job it was designed to be done.

We say Sweden is 10 years ahead of us or 15 years ahead of us, but in that particular instance there isn't a demonstrated program as to the effect of stopping pollution, because we haven't stopped the pollution.

Dr. **LABASTILLE.** That is right. I don't think we will find such a spot or such a program because of the implications of the global transport. Even if you cleaned up 90 percent, you couldn't stop this stuff from circulating around.

I want to say two things about that. In Switzerland, the United Nations meeting that I went to came up with the statement that almost 100 million tons of sulfur dioxide are being produced annually by industrial applications in the United States, Canada, Japan, Eastern and Western Europe, and the Soviet Union—100 million tons of sulfur dioxide is a sizable amount.

To give you another example of how tremendous this transport can be, on Mauna Loa volcano in Hawaii, where I stopped at the observatory to examine their program. I was actually shown electronic microscope photographs of sulfuric acid droplets collected near the top of that volcano, 11,000 feet high, that they suspect had come in from the American continent. At other times of the year, they had dust particles from the Gobi Desert in China, which they were able to identify with an electronic microscope. The point is, that this transport occurred, in the case of the dust, over 10,000 miles. The sulfuric acid came from perhaps 5,000 miles away.

How are you going to have a regional program due to the fact of the amount going up and the fact that it is moving around. How can you design a local program or do anything that is going to improve the effectiveness unless everybody cleans up altogether?

Mr. **Carney**. You said that Japan has made a marked improvement in their air quality. Certainly they are subject to pollution from that same source that we speak of, the global source that we speak of.

You said you were not in Japan, but do you know of some of the techniques they have utilized to accomplish what they have? Have they stopped burning hydrocarbons?

Dr. **LaBastille**. I believe it was the use of scrubbers and other technological controls.

Mr. **Martin**. Dr. LaBastille, we thank you very much for your testimony.

As chairman of this meeting, I don't want to have it said that I ran us over schedule; so we are going to have to try to keep within some type of time frame and maybe we can hit the highlights, so these people who have traveled so far can get to questions.

Our next witness is Bill Roden, of Diamond Point. He operates a resort there and has a newspaper column on fishing and wildlife.

Mr. **Roden**. Congressman, I want to thank you for telling us about the Hudson and the Potomac. Really, we Adirondackers just want done to the air what they are doing for the water down there. I might also say when a lady starts getting green hair from the water, that might be something we should publicize. I'm sure they would give us much additional support for our cause.

My name is Bill Roden. I am a resort owner in New York's Adirondack Mountains. My wife and I operate Trout Lake Club. I do want to get the record clear, if I may. We have a resort on a small lake in the southeastern part of the Adirondack Park. My family has been at this location since 1924, and my children are the fourth generation of Rodens who work at our resort.

I am a newspaper columnist. I am an active fisherman and hunter, and I am active in fish and wildlife conservation organizations at the local regional and State level. I have just left the New York State Conservation Council meeting in Watertown, and I want you to know they are solidly behind the effort to do something about acid rain.

We are not opposed to studying. We say go ahead and continue to study, but let's do something.

Our lake, Trout Lake, still has a pH of over 7—which is considered neutral—and is, therefore, not yet affected by acid precipitation or what we laymen call acid rain. However, last winter I decided to find out for myself what was coming into our valley with the snow and rain. I acquired a LaMotte pH color comparator to measure sulfuric acid content. Now I am not a scientist and, of course, this information is not given to you as scientific fact—just a layman's effort to learn.

I started measuring snow and rainfall on February 11, and the last reading taken in this count is July 12—5 months. In that period I measured the acidity of 50 snow and rainstorms. None measured a neutral seven. Only 14 of the 50 reached 6 or over. Eleven were 4 or 4.5. Half were in the 5–5.5 range.

We have a good buffering watershed in our valley—but I must ask myself how long can it clean the acid out of the snow and rain we are receiving. I think you will find interesting that 2 weeks ago, I measured a short rainfall that was not more than a tenth of an inch in total, and it came out at a 3.5. That was the lowest we have ever had in my period of measuring. It only lasted about a half hour, incidentally.

We have fantastic fishing at our resort—bass reaching 5½ pounds are not unusual. But bass is one of the first species to disappear as the pH of a body of water drops. How long before fishing is no longer one of our resort's principal attractions? The warning is already there in my backyard—a brass bell that glistened in the sun for 25 years shines no more—it has turned green in the last 3 years, like the lady's hair. Now, that is an honest fact. You are invited to come and see it. I didn't do it. It came from the air. Nothing has touched it but the air.

To the west of me is Canada Lake, a body of water with a surface area of some 525 acres, formerly known for its bass fishing. It is a very popular recreation lake with a number of resorts and many summer cottages on its shore. Today the bass are gone. The reading is down to 5.2 and the fishermen from that area are understandably angry. The winds from the west that cross Canada Lake cross Trout Lake.

This summer, the cottage owners on the lake tried to lime it, to see if they could help it. It is an expensive proposition. And why should they have to do it? Why should that lake, which has had bass fishing for years and years and years all of a sudden have to go to liming because of what somebody else does?

You have asked me to present the viewpoint of the small businessman and give you some idea of the economic impact of acid rain on our area. It is difficult to cover all aspects, and you must tolerate rough figures. We do have some studies which indicate the value of fishing to the New York State economy. In 1979, it was estimated that there were 1,375,000-plus-or-minus anglers who fished in New York State. The value of this activity to our economy is estimated by our department of environmental conservation researchers at somewhere between $518 million and $601 million in 1979.

In my home county—Warren County—our tourism office estimates the value of our sport and recreational fishing at approximately $20 million in 1980 alone. Our county spends over $200,000 per year on tourism promotion; $34,000 of that to attract fishermen to Warren County. While the Warren County investment is heaviest, it is important to remember that there are 12 counties that make up the Adirondack Park. Fishing is a substantial part of our total recreation area economy.

Mr. **Martin**. We should keep in mind that all those dollars are being spent to promote fishing within Warren County, which has a population of 50,000.

Mr. **Roden**. At the most. Incidentally, you make the point I hoped to demonstrate how important it is to those 50,000 of us who live in Warren County. A county whose principal industry is the resort and recreation business.

I have several other stories here, but I won't go into them all. I do want to tell you this. On my way to the convention the other day, I drove down through Old Forge—I never go down out of the park if I can avoid it, and I can get to Watertown by going through the park, and I stopped at a bookstore there. I casually mentioned, because Old Forge is known by our local people as the center of acidity—the lady who was behind the counter was very friendly, and I was looking at some Adirondack book—and I said, "What is the story on acid rain these days over here?" She said, "I guess I know. I just had to replace all the copper pipe in my house."

Gentlemen, I am going to wind up, if you will, with just a little preaching. As a resort owner and as one who lives in the Adirondacks which depends on the resort and recreation industry as its economic base, I am apprehensive. I am sad that governmental regulations permit industries in other parts of our wonderful country to kill fish in my area. I also feel that perhaps the fish are just the indicators of worse things to come. Do we have to wait until the sulfuric and nitric acid in the rain and snow is proven to affect people?

I cannot correct this measure—you must. When our forefathers established our Constitution they devised an incomparable formula for living together, and they gave the Congress the authority to enforce it and keep it effective. In the suburbs, if my neighbor has a dog that barks all night or a stereo that disturbs the peace, I go to my town government and the problem is corrected.

To live together we have to consider each other. Where there is a national problem, such as this one, you—the Members of Congress—are the ones we turn to and the ones we expect to correct a bad situation. We know and you know what is causing the acid precipitation and where it originates. It can be corrected—I only hope that you will accept and understand the importance of what is presently happening and what is about to happen and take the necessary steps to stop this environmental degradation before it becomes a national disaster.

I hate to preach, but I had to say that to you.

One last thing, Mr. Martin: The New York State Senate passed a resolution through the efforts of our own local senator, Ronald Stafford, of Plattsburgh, and I have supplied copies to the committee. It has to do with acid rain.

[Mr. Roden's prepared statement, a copy of the legislative resolution, and Mr. Roden's outline for testimony follow:]

Statement by
William H. Roden
Before the Subcommittee on Natural Resources, Agriculture Research and Environment
Committee on Science and Technology
U. S. House of Representatives

My name is William Roden. I am a resort owner in New York's Adirondack Mountains. My wife and I operate Trout Lake Club, a family housekeeping cottage resort on a small lake in the southeastern part of the Adirondack Park. My family has been at this location since 1924 and my children are the fourth generation of Rodens to work at our resort. I'm also a newspaper columnist--I write a weekly outdoor column known as the "Adirondack Sportsman" which is carried regularly in three northern New York papers and, on occasion, in as many as eight others. I'm an ardent and frequent fisherman and hunter in our region; and active in fish and wildlife and conservation organizations on the local, regional and state levels. On behalf of myself, my friends and neighbors and fellow fishermen, I extend thanks for the invitation to be here today. I should also tell you that when they heard I was coming they rallied around and supplied me with much information on the problems they are experiencing.

Our lake, Trout Lake, still has a pH of over 7 (which is considered neutral) and is, therefore, not yet affected by acid precipitation or what we laymen call acid rain. However, last winter I decided to find out for myself what was coming into our valley with the snow and rain. I acquired a LaMotte pH Color Comparator to measure sulphuric acid content. Now I'm not a scientist and, of course, this information is not given to you as scientific fact. Just a layman's effort to learn. I started measuring snow and rainfall on February 11 and the last reading taken in this count is July 12--5 months. In that period I measured the acidity of 50 snow and rainstorms. None measured a neutral 7. Only 14 of the fifty reached 6 or over. Eleven were 4 or 4.5. Half were in the 5-5.5 range. We have a good buffering watershed in our valley--but I must ask myself how long can it clean the acid out of the snow and rain we are receiving. We have fantastic fishing at our resort--bass reaching 5½ lbs. are not unusual. But bass is one of the first species to disappear as the pH of a body of water drops. How long before fishing is no longer one of our resort's principal attractions? The warning is already there in my backyard--a brass bell that glistened in the sun for 25 years shines no more--it has turned green in the last 3 years.

To the west of me is Canada Lake, a body of water with a surface area of some 525 acres, formerly known for its bass fishing. It is a very popular recreation lake with a number of resorts and many summer cottages on its shore. Today the bass are gone. The reading is down to 5.2 and the fishermen from that area are understandably angry. The winds from the west that cross Canada Lake cross Trout Lake.

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In my home county--Warren County--our Tourism Office estimates the value of our sport and recreational fishing at approximately 20 million dollars in 1980 alone. Our County spends over $200,000 per year on tourism promotion; $34,000 of that to attract fishermen to Warren County. While the Warren County investment is heaviest it is important to remember that there are 12 Counties that make up the Adirondack Park. Fishing is a substantial part of our total area economy. 264 Lakes and ponds no longer have a recreational fishery and the number grows annually.

Because the acid situation was first discovered in the Adirondacks in remote, high-elevation ponds, there is a tendency to think that they are the only ones affected. This is not so. We now have a number of lakes in the 1,000-acre category at lower elevations which are sterile. There are a number of resort lakes which are presently on a rapid down-trend and are expected to lose their ability to support fish life in the near future. Canada Lake, mentioned before, Big Tupper Lake and Cranberry Lake (fifth largest in the Adirondack Park) are three well-known Adirondack resort lakes that are currently seriously threatened.

One of the largest bodies of water with a serious acid problem is Big Moose Lake in Herkimer County in the western part of the Adirondacks. The surface of Big Moose is in excess of 1300 acres. It once had an outstanding fishery including brook trout, lake trout, and bass. President Grover Cleveland was very familiar with Big Moose Lake and fished it. He visited Dart Lake Lodge which was a small lakeside resort on the outlet stream of Big Moose Lake. The pH reading for Big Moose Lake today is 4.17. I'm sure you've been told by professionals who have testified before you previously such waters will support no fish life. Said one of our fishery biologists recently, "With that kind of a pH, I would expect no sport fishery to be possible for all practical purposes. Much too large for a liming program. As far as the Department of Environmental Conservation is concerned, nothing can be done."

This is a book from my Adirondack Library. It was published in 1941. The author, Leighton Brewer, is unknown to me but the title, VIRGIN WATER, caught my eye as a fisherman. Mr. Brewer was in the High Peaks of the Adirondacks. He writes:

"The story of the Flowedlands is also instructive. As I have already mentioned, it was formerly a swamp, but converted by a five-foot dam into a lake some three quarters of a mile in length. Through this lake flows the Opalescent River, which is, in fact, the main branch of the Hudson, only a few miles below where, as Feldspar Brook, it bubbles out of the ground at Lake Tear-of-the-Clouds.

"For some time no signs of fish appeared, although Lake Colden, just above, was overstocked with trout. Then one July morning about five years after the dam had been built, someone passing across noticed large trout rising, whereupon he put his rod together and proceeded to take five fish totaling 15½ pounds. These fish multiplied very fast, for in a few years the lake was just boiling with trout from 1 to 2½ pounds and a certain number of bigger ones.

"They grew rapidly, for all those caught were very fat and had small heads, indicating that they were young fish. This lake was soon fished without respite from the first of June until the last day of August, with an average of three rods a day; and I have estimated the annual toll was more than five thousand trout. Yet it continued to yield more and better fish than any other lake in the whole region."

The New York State Department of Environmental Conservation is repairing that dam at the Flowedlands that Brewer mentions and in order to do so, has drained the water from the pond. There was no delay or hesitation for today there are no fish. You should know, too, that Lake Colden, Lake Tear-of-the-Clouds, the upper Opalescent River and, in fact, virtually all of the High Peaks ponds are sterile and have no fish. When you climb New York State's highest mountain, Mount Marcy, you cannot catch your dinner of brook trout in a pond along the way as I did as a young man.

In certain parts of the Adirondacks where the acid problem is most severe, problems with household water supplies are developing. Acidified water is leaching copper from copper water pipes and lead from the soldered joints into water supply systems. There is also evidence that excessive copper in water is having a bad effect on septic systems. Consider the long-term economic effect of this problem if it becomes widespread.

Recently at a meeting of the New York State Conservation Council a friend from Rome, New York, stopped to tell me a story he found quite upsetting. He is an experienced trapper. Incidentally, in New York State trappers have an annual income of more than 12-million dollars and there were some 22,000 trapping licenses sold last year. During the last trapping season, my friend had gone back into an area he had trapped frequently in the past with success. His sets were for weasel, mink, otter, fisher and raccoon. His success was zero. And then the reason dawned on him. There were no fish; therefore, the animals that feed on fish had to leave. How can you put a dollars and cents value on that? The environment will support only so much wildlife. You can't move a population from one area to another populated area and have them all survive so there must be a tragic loss of wildlife numbers and an unmeasurable decline in the quality of life.

At the Syracuse College of Environmental Science and Forestry we have a group of scientists and biologists who are conducting an ongoing research program on the effect of acid rain on plant life and trees. Their findings are not yet conclusive. But their implications are frightening. The acid in rain and snow scour tree leaves, causing what the scientists call "cuticular" damage which, in turn, greatly increases the tree or plant's susceptibility to disease. Laboratory studies have demonstrated that plants in grounds saturated with acid rain suffer from a lack of nutrition. Research indicates that the acid content of rain and snow leaches nutrients out of the soil and, therefore, they are not available to the growing plants. Certain species of trees may be particularly susceptible to this action. For the Adirondack area, this is a direct attack on our principal year-round industry-- the wood products industry. Most of our forest land that is privately-owned is managed in some fashion. Several paper companies have large holdings in the area and have their lands on a sustained yield basis. Most other private landowners periodically cut for lumber, pulp, and firewood on their lands. If the trees are destroyed, the loss would be obvious and would need no explanation from me and this is a real possibility at some time in the future if nothing is done. But perhaps more insidious would be a substantial reduction in the growth rate which might be caused by this nutrient loss. Foresters tell us this is a very real possibility in the near future if the acid rain situation is not corrected.

As a resort owner and as one who lives in the Adirondacks which depends on the resort and recreation industry as its economic base, I am apprehensive. I am sad that governmental regulations permit industries in other parts of our wonderful country to kill fish in my area. I also feel that perhaps the fish are just the indicators of worse things to come. Do we have to wait until the sulfuric and nitric acid in the rain and snow is proven to affect people?

I can't correct this measure--you must. When our forefathers established our Constitution they devised an incomparable formula for living together and they gave the Congress the authority to enforce it and keep it effective. In the suburbs, if my neighbor has a dog that barks all night or a stereo that disturbs the peace, I go to my Town Government and the problem is corrected. To live together we have to consider each other. Where there is a national problem, such as this one, you--the members of Congress--are the ones we turn to and the ones we expect to correct a bad situation. We know and you know what is causing the acid precipitation and where it originates. It can be corrected--I only hope that you will accept and understand the importance of what is presently happening and what is about to happen and take the necessary steps to stop this environmental degradation before it becomes a national disaster.

July 17, 1981

STATE OF NEW YORK

The Legislature

In Senate ~ In Assembly

LEGISLATIVE RESOLUTION memorializing the Honorable Ronald W. Reagan, President of the United States, and the Congress of the United States to provide the leadership and funds necessary to bring a resolution to the acid precipitation problem

Introduced by Sen. ______ Introduced by M. of A. ______

The Senators whose names are circled below wish to join me in the sponsorship of this resolution:

Ackerman
Anderson
[✓ Auer]
Babbush
[✓ Barclay]
Bartosiewicz
Beatty
Berman
Bernstein
Bogues
[✓ Bruno]
Caemmerer
Calandra
Connor
[✓ Cook]
[✓ Daly]
[✓ Donovan]
Dunne
Eckert
[✓ Farley]
Floss
Flynn
Galiber
Gallagher
Gazzara
Gold
Goodhue
Goodman
Halperin
[✓ Johnson]
Kehoe
Knorr
Lack
LaValle
[✓ Leichter]
Levy
Lombardi
Marchi
Marino
Markowitz
Masiello
Mega
Mendez
Nolan
Ohrenstein
Owens
Padavan
Perry
[✓ Pisani]
Present
Rolison
Ruiz
Schermerhorn
Smith
Solomon
Stafford
[✓ Trunzo]
Volker
Weinstein
Winikow

Ronald Stafford

Senate Introducer's signature

The Members of the Assembly whose names are circled below wish to join me in the sponsorship of this resolution:

Abramson
Barbaro
Behan
Bianchi
Boyland
Bragman
Branca
Burrows
Bush
Butler
Casale
Chesbro
Cochrane
Cohen
Connelly
Conners
Cooke
D'Amato
D'Andrea
Daniels
Davis
Dearie
Del Toro
DiCarlo
Dugan
Emery
Engel
Esposito
Eve
Farrell
Feldman
Ferris
Fink
Finneran
Flack
Flanagan
Fortune
Fossel
Friedman
Goldstein
Gorski
Gottfried
Graber
Grannis
Green
Griffith
Hague
Hanna
Hannon
Harenberg
Harris
Hawley
Healey
Hevesi
Hinchey
Hirsch
Hoblock
Hochbrueckner
Howard
Hoyt
Jacobs
Jenkins
Johnson
Keane
Kelleher
Kennedy
Kidder
Kisor
Koppell
Kremer
Kuhl
Lafayette
Lane
Larkin
Lasher
Lentol
Levy
Lewis
Lipschutz
LoPresto
MacNeil
Madison
Marchiselli
Mazza
McCabe
Miller, H.M.
Miller, M.H.
Montano
Morahan
Murphy
Murtaugh
Nadler
Nagle
Newburger
Nine
Nortz
O'Neil
Orazio
Parola
Passannante
Perone
Pillittere
Prescott
Proud
Rappleyea
Rath
Reilly
Rettaliata
Riford
Robach
Robles
Ruggiero
Ryan
Saland
Sanders
Schimminger
Schmidt
Sears
Seminerio
Serrano
Shaffer
Sheffer II
Siegel
Silver
Siwek
Skelos
Smoler
Spano
Stavisky
Stephens
Straniere
Sullivan, E.C.
Sullivan, F.M.
Sullivan, P.M.
Tallon
Talomie
Vann
Velella
Viggiano
Walsh, D.B.
Walsh, S.P.
Warren
Weinstein
Wemple
Weprin
Wertz
Wilson
Winner
Yevoli
Zimmer

______

Assembly Introducer's signature

re
rcvd
3/81

INTRODUCTION OF ALL RESOLUTIONS

To introduce this resolution:
Sign one covered copy, circle co-sponsors and hand it up at the desk of the house with six other copies

If the resolution is to be offered in the other house:
Sign the remaining covered copy and give that to the sponsoring member of the other house together with six other copies

WHEREAS, Acid precipitation has increasingly become a major national and international pollution problem resulting in serious environmental damage; and

WHEREAS, The incidence of acid precipitation has become a matter of serious concern to our citizens and to our natural resources; and

WHEREAS, Recent reports indicate gradually deteriorating water quality particularly in the Adirondack region; and

WHEREAS, Efforts must be made to provide a solution to this local, state, national, and international problem; and

WHEREAS, The tourist industry, hunting and fishing groups, fish and wildlife organizations, the fisheries industry, the agriculture community, resource conservation groups, and environmental groups, have called for action to eliminate sulphur dioxide and nitrogen oxide emissions, which result from the burning of fossil fuels and which are major factors in the creation of acid precipitation; now, therefore, be it

RESOLVED, That this Legislative Body memorializes the Honorable Ronald W. Reagan, President of the United States, and the Congress of the United States to provide the leadership and funds necessary to bring a resolution to the acid precipitation problem; and be it further

RESOLVED, That this Legislative Body opposes any relaxation of the promulgated air quality standards and regulations designed to minimize sulphur dioxide and nitrous oxide discharges, as reflected in the Federal Clean Air Act of 1970, which might deleteriously affect the environmental quality of states downwind, and in particular the Adirondack Park; and be it further

RESOLVED, That copies of this Resolution, suitably engrossed, be transmitted to the Honorable Ronald W. Reagan, President of the United States and to the Speaker of the House of Representatives of the United States, to the President Pro Tempore of the United States Senate, and to each member of the Congress of the United States from the State of New York.

BILL RODEN

STATEMENT -- SEPTEMBER 18, 1981

SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT

Billiam Roden
Trout Lake Club
Diamond Point, NY 12824

Bill Roden operates a resort in the Adirondack Area and writes a newspaper column on fishing and wildlife.

I. Small business approach

- A. Concern as a resort owner
- B. Problems of today
- C. Problems of the future if no corrective action is taken

II. Examples from several writings

- A. Description of the area from long ago
- B. Description of the area today

III. Value of fishing in general

- A. Fishing situation in the area
- B. Specific information about fishing resorts in Adirondacks
  - -Concerns of resorts owners

IV. Trapping

V. Forestry

- A. Wood products
  1. Largest industry in Adirondack Area
  2. Damage to industry by acid precipitation
  3. Economic situation resulting from wood products and acid precipitation damage

Mr. **Martin**. I wanted to point out one thing: As a former member of the State legislature, I am sure you are aware those of us in upstate New York worked long and hard for funding to promote, not only on a tourism basis, our fishing industry; we spent substantial dollars for stocking, and so forth. It is kind of self-defeating when you find out once we spend all that money, we don't have as many fish. We still have a lot of fish.

Mr. **Roden**. I will be glad to tell you some places. There are still a few.

Mr. **Mitchell**. Thank you for your testimony, Mr. Roden. As usual, I enjoyed it a great deal. I just have one question. The lady who was replacing copper plumbing in her house, why did she do it? Did it pollute the quality of the drinking water? Did it leak or corrode?

Mr. **Roden**. I would probably be smart to defer this to Ann, but I will tell you what the lady told me. She told me that the acid in the water caused the copper to erode internally and form little pinholes in the copper pipes.

Mr. **Mitchell**. It eats right through the plumbing.

Dr. **LaBastille**. The people feel a new plumbing system will now only last 5 to 7 years before it pits through, through acid corrosion. It used to stay there 50 years. It is even worse in Sweden. They have lost plumbing in 3 years there.

Mr. **Martin**. Mr. Carney?

Mr. **Carney**. I have no questions. I certainly appreciate your taking time to come and give us your testimony.

I think you can see the Congress has a little bit of a problem. Indeed, my being a layman, I would agree with you, we know what the problem is and what the source of the problem is. From the standpoint of congressional action sometimes we have to have proof-positive before we can go out and tell someone to shut down their smokestacks.

You heard this morning the scientific community does not have the resources in dollars and the time to give us the proof-positive, so we can move forward. I think that is the one message that I can say personally—I have learned about through coming here—we have to make a commitment to help them give us the proof-positive to correct this.

In the meantime, as you said, you have no problems with studies, but let's start doing what we know is cost-effective and what we know we can do right now with the present state-of-the-art and the present technology.

Mr. **Roden**. Nowhere have I said don't study. I believe in study. I want to continue.

Mr. **Carney**. That is what I said. I think we have to continue so we can get that proof-positive, but we have to move, just as we said.

Mr. **Roden**. I think we not only should continue studying because I think there is a great deal more beyond that we can do. But, in the Ohio Valley, in Pittsburgh, in Buffalo, those things we can do now. We must do. The reason I say that is, we didn't have those stacks 10 years ago. They were put in after the Clean Air Act went in. Now we have the acid rain mess.

All we did was make a mistake. We didn't go the full shot. Now, I say continue the study. Go into all the other things, but do these corrective measures that we know will take sulfur out of the air, we know will take nitric oxide out of the air, because we know we have to take the acids we put in out, and continue the studies at the same time.

Mr. **Carney**. Mr. Sensenbrenner?

Mr. **Sensenbrenner**. Mr. Roden, I hope you were here this morning when the scientists testified.

Mr. **Roden**. I wish I had been, but I couldn't make it.

Mr. **Sensenbrenner**. Then permit me to summarize, if I can, in perhaps one or two lines.

The scientific community that came before us here this morning, I think agreed to disagree, in that there is no simple solution to the problems of acid rain. We heard testimony that even if the amount of NO_x and SO_x emitted from the stacks of the Ohio Valley were dramatically reduced, there would probably not be an appreciable increase in the quality of the water and ground minerals in this area.

We also heard other testimony that said it is very hard to determine what acidifies lakes, because some lakes in the Adirondack regions are becoming very acidic and others are not becoming acidic at all.

Given the fact scientists don't really know what we ought to do, and given the economic impact on an area of the country that is upwind from the Adirondacks, what do you recommend that Congress should do?

Mr. **Roden**. As a layman, I will put it very simply. We didn't have it 10 years ago in the Adirondacks. We have it now. What has changed in that interim? I think you know the answer to that. As a layman, I am told the answer by the professionals. All I would say is what someone said in one of these oversimplified studies: If you have sulfuric acid coming out of the air and nitric oxide coming out of the air, it has to originate someplace, so keep it from going into the air where it originates. That is all I am asking. If I have to pay for it, I will pay for it, and so will everyone else concerned. Perhaps we have to go all the way to Nevada to take care of this. All the reports I hear stop at the Ohio River Valley, which it seems a little unfair, but by the same analogy, if that is where it comes from, stop it.

Mr. **Sensenbrenner**. I think what evidence we do have about this problem of acid rain, in some instances it is a regionalized problem and in other instances it is a worldwide problem. Otherwise, how could you account for the fact that at the top of Mauna Loa there is high acidity in the rain and they are thousands of miles away from any coal-fired powerplant or any steel mill?

Again, I would caution you that there isn't any easy answer to this problem.

Mr. **Roden**. I don't say there is, but the volcanoes were erupting before 10 years ago. Our problem has been in the last 10 years.

Mr. **Sensenbrenner**. Maybe this is another example of the fact that the Clean Air Act might not have been though through in all of its ramifications.

Thank you.

Mr. **Martin**. Moving right along with our continuing effort to keep on our time track, I want to introduce Sue Dyer, who, from the perspective of the Saranac Lake Chamber of Commerce, will enlighten us on the impact and ramifications that acid rain is having, not just in the Saranac Lake area, but by extrapolation the entire region.

Ms. **Dyer**. Mr. Chairman, I am Janet Sue Dyer, the executive director of the Saranac Lake Area Chamber of Commerce. I have worked in that position for 11 years.

Our chamber represents 380 business and private members. I speak on behalf of the people of this area, and I wish to thank you for inviting me here today. When news of your committee's interest in our acid rain problem was made known, unsolicited information came pouring into our office to support concerns about acid precipitation affecting all areas of the Adirondack Park. These are the facts that I present to you today.

Saranac Lake lies in northern New York State, which borders Canada, in the upper third of the Adirondack Park. The park covers approximately 6 million acres and contains 2,877 fresh water lakes. This region is a unique mix of private and State forest lands. Saranac Lake Village, the largest population center—approximately 7,000—within the park, lies within two upstate New York counties, Franklin and Essex. Statistics used later in the statement will reflect those taken from both of these counties.

The Adirondacks are a 9,000-square-mile tourist community. The award-winning "I Love New York" tourism campaign spends $10 million per year on advertising. The largest portion is spent on the Adirondacks. Gov. Hugh Carey has doubled the matching funds portion of the State advertising budget for next year, thereby making a part of $2 million available to areas such as ours to expand our advertising efforts. These funds are in addition to the thousands spent by organizations such as our chamber of commerce.

We believe the advertising campaigns are working: $200 million were spent by tourists within the park last year. New York State Department of Commerce figures demonstrate the fact that the Adirondacks are the single largest attraction for the visitor to our State, other than New York City. What draws visitors to Franklin County is not the man-made attractions but rather the natural beauty of mountains, lakes, and streams.

A total of $17.7 million were spent by tourists in Franklin County last year, and $39.1 million in Essex, for a total of $56.8 million worth of tourism expenditures, within the two counties that are of immediate concern to Saranac Lake. I am sure statistics such as these are thrown at you every day, but to an area such as ours, they are our life-blood.

The Adirondack lakes and streams have some of the finest sport fishing in the East. The fishermen contributed $10 million to the economy of a single county in the Adirondacks—Franklin. There are 2,877 lakes and ponds in the Adirondacks with 282,154 surface acres. Two hundred and sixty-four of these lakes and ponds with 11,581 surface acres no longer support fisheries and many do not support aquatic life of any sort, including crayfish, mussels, and salamanders. Even the birds no longer nest there. Nearly 10 percent of our lakes are dead.

If you will allow, I will attempt to break these figures down into the area of concern that brings us here today: Acid precipitation and what it will do to our fishing economy.

A total of 11,578 fishing licenses are sold in Franklin County every year and 14,134 in Essex County, for an income for the State of $209,334.78. Selecting just Franklin County to break these figures down even further, 10,022 annual licenses are sold in Franklin County. Using a multiplier of 17,047 fishing days per license and a minimum expenditure of $31.80, we can arrive at a conservative figure of $5,432,872.08 spent every year within Franklin County. Nonresident licenses, both 7-day and 3-day, are sold within Franklin County, adding another 1,556 licenses and changing the multiplier to reflect the 3 and 7 days and using the same daily expenditure of $31.80, another $211,024.84 can be added to the figure expended by the fisherman purchasing annual licenses, for a total of $5,643,896.88 spent in Franklin County alone every year by those people purchasing licenses within the county.

Based on additional information presented in the 1976–77 statewide angler survey—W. Kretzer and L. Klatt, 1981—the visitors/tourists substantially increased those figures in Franklin County: 29,034 anglers generated 323,543 angler days on waters in Franklin County. With this survey and the Consumer Price Index for 1981, the daily expenditure for people fishing in Franklin County and utilizing these figures, the total revenue generated by fishermen in 1977 based on 1981 dollars was $10,288,677.

The possibility of losing $10 million every year is staggering in an area that the New York State Department of Labor research analysts estimate has a per capita income of $5,139 and the highest unemployment rate in the Nation of 13.5 percent—year-round average.

A marina operator in Saranac Lake told me he would lose $50,000 per year if there were no fish in lower Saranac Lake. There are four marinas in Saranac Lake.

The publicity that the acid precipitation is generating is affecting our economy. A New York representative promoting hunting and fishing in the Adirondack Park at a recent sportsman's show in Harrisburg, Pa., was asked why he was attending: "We heard all of your fish are gone." Many visitors who come to the local "I Love New York" tourism office ask, "Are there any lakes left that have fish in them?" Other visitors who come to the Saranac Lake chamber office ask if it is safe to swim in the waters; some say, "They knew that the water killed all of the fish but would it hurt to swim in it."

The New York State Department of Health does not help but scares the be-jesus out of people. With each fishing license, a booklet is distributed outlining rules and regulations, covering all aspects of fishing in New York State which includes on page 2 this warning: "To minimize potential adverse health impact, the New York State Department of Health recommends that you eat no more than one meal—one-half pound—per week of fish taken from any water in the State"—hardly conducive to tourist promotion.

A Saranac Lake group representing 300 area people and 30 organizations have banded together to form the "Coalition of Adirondacks to Neutralize Acid Rain Inflow." Not merely a group of environmentalists, the membership is made up of fishermen, teachers, promotion groups, and the average citizen of the area. They attempt to educate the people in our area and our elected officials to the silent danger of acid precipitation.

In March of this year, the Adirondack Association, the dean of promotion groups for the Adirondack counties, unanimously passed a resolution urging the President, the Congress, the Governor, and the State legislature to provide the leadership and funding necessary to bring about a solution to our dilemma.

In June of 1981, the New York State Senate passed a similar resolution petitioning the Honorable Ronald W. Reagan, President, and the Congress of the United States to bring about a resolution of the acid rain precipitation problem by opposing any relaxing of the Federal Clean Air Act of 1970, which minimizes sulfur dioxide and nitrogen dioxide discharges.

Further, the State of New York is sufficiently concerned about this creeping disaster that it has petitioned the Environmental Protection Agency to stop the request from six States to increase their emissions and is suing three plants that have already been allowed to relax their standards: one in Michigan, one in Ohio, and another in Illinois.

An article in the June 8, 1981, issue of the New York Times entitled "Acid Rain in Adirondacks Disrupts the Chain of Life," says about the impact on tourism: "For every disappointed fisherman who may go elsewhere other visitors have come along."

Instead of building on this multimillion-dollar industry, we are standing still. We are exchanging one market for another—a no-growth approach in an area dependent upon the growth of tourism. Perhaps one day, the visitor to our area will view our beautiful crystal-clear lakes and streams and listen to a tour guide tell tall fish stories about the not-so-distant past when the economy of the park was based on the sportsman.

The acid rain question will be debated for years by environmentalists and the industries most affected financially by the Clean Air Act: those who are affected the most by this debate and the failure to find a speedy answer to the problem are people such as the ones I represent, those in the middle, those without a lobby. We are the innocent victims of something that we cannot defend ourselves against—we have no industry. But we inherit the pollution of industrial areas. We, in the middle, invite both the environmentalists and the blue and white-collar workers who labor in a pollution-emitting industry to vacation in the Adirondacks so that we, too, can make a living.

Every publication used in the preparation of this statement came to the same conclusion: that the politician will be our savior or the nemesis in this debate on acid precipitation. Politics is charged with mediating human choices. Sometimes you improve the status quo by doing something, and other times you improve it by doing nothing.

When you succeed, you expand your set course of action. The millions of tons of sulfur dioxide and nitrogen dioxide that have been cut back and are no longer contributing to the acid problem prove the success of the Federal Clean Air Act.

Your choice should be simple; you can improve the status quo by doing nothing and leave the present Federal Clean Air Act alone, or you can, faced with this success, expand the set course, strengthen the Clean Air Act and stop the death of Adirondacks lakes and help to preserve and build on our fragile economy.

A small chamber of commerce in one of this Nation's most beautiful areas could be accused of having a "jaws" mentality. We can keep shifting the vacationing fisherman to lakes with viable fisheries, or we can depend on the leadership of this Nation to put a halt to this creeping ecological and financial disaster and set already affected areas on the road to recovery, so that the tall fish tales told will be ones experienced this morning, next week, next year, next decade.

Thank you.

[The prepared statement of Ms. Dyer follows:]

Saranac Lake Area
Chamber of Commerce

518-891-1990
30 Main Street
Saranac Lake N. Y. 12983

STATEMENT BY JANET SUE DYER

FOR THE

HOUSE SUB-COMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT

Mr. Chairman, Committee Members, I am Janet Sue Dyer. I am the Executive Director of the Saranac Lake Area Chamber of Commerce covering upstate New York County, Essex and Franklin. I have worked in that position for 11 years. Our Chamber represents 380 business and private members. I speak on behalf of the people of this area and I wish to thank you for inviting me here today. When news of your committee's interest in our acid rain problem was made known, unsolicited information came pouring into our office to support concerns about acid precipitation affecting all areas of the Adirondack Park. These are the facts that I present to you today.

Saranac Lake lies in Northern New York State in the upper third of the Adirondack Park. The park covers approximately six million acres of land and contains 2,877 fresh water lakes. This region is owned by the people, protected by the State of New York...the Adirondack Park. Saranac Lake Village, the largest population center, (approximately 7,000) within the Park, lies within two counties, Franklin and Essex. Statistics used later in the statement will reflect those taken from both of these counties.

The Adirondacks are a 9,000 square mile tourist community. The award-winning "I Love New York" tourism campaign spends 10 million dollars per year on advertising; the largest portion is spent on the Adirondacks. Governor Hugh Carey has doubled the matching funds portion of the State advertising budget for next year, thereby making a part of 2 million dollars available to areas such as ours to expand our advertising efforts. These funds are in addition to the thousands spent by organizations such as our Chamber of Commerce.

We believe the advertising campaigns are working; 200 million dollars were spent by tourists within the Park last year. New York State Department of Commerce figures demonstrate the fact that the Adirondacks are the single largest attraction for the visitor to our State, other than New York City. What draws visitors to Franklin County is not the man-made attractions but rather the natural beauty of mountains, lakes and streams.

17.7 million dollars were spent by tourists in Franklin County last year and 39.1 million in Essex; for a total of 56.8 million dollars worth of tourism expenditures, within the two counties that are of immediate concern to Saranac Lake. I am sure statistics such as these are thrown at you every day; but to an area such as ours, they are our life-blood.

The Adirondack lakes and streams have some of the finest sport fishing in the East. The fishermen contributed 10 million dollars to the economy of a single county in the Adirondacks--Franklin. There are 2,877 lakes and ponds in the Adirondacks with 282,154 surface acres. 264 of these lakes and ponds with 11,581 surface acres no longer support fisheries and many do not support aquatic life of any sort, including cray fish, mussels and salamanders, even the birds no longer nest there. Nearly 10% of our lakes are dead.

If you will allow, I will attempt to break these figures down into the area of concern that brings us here today: Acid precipitation and what it will do to our fishing economy.

11,578 fishing licenses are sold in Franklin County every year and 14,134 in Essex County for an income for the State of $209,334.78. Selecting just Franklin County to break these figures down even further, 10,022 annual licenses are sold in Franklin County, using a multiplier of 17.047 fishing days per license and a minimum expenditure of $31.80 we can arrive at a conservative figure of $5,432,872.08 spent every year within Franklin County. Non-resident licenses, both 7 day and 3 day, are sold within Franklin County, adding another 1,556 licenses and changing the multiplier to reflect the 3 and 7 days and using the same daily expenditure of $31.80; another $211,024.84 can be added to the figure expended by the fisherman purchasing annual licenses for a total of $5,643,896.88 spent in Franklin County alone every year by THOSE PEOPLE PURCHASING LICENSES WITHIN THE COUNTY.

Based on additional information presented in the 1976-77 statewide Angler Survey (W. Kretzer and L. Klatt, 1981)--The visitors/tourists substantially increased those figures in Franklin County: 29,034 anglers generated 323,543 angler days on waters in Franklin County. With this survey and the Consumer Price Index for

1981, the daily expenditure for people fishing in Franklin County and utilizing these figures, the total revenue generated by fishermen in 1977 based on 1981 dollars was $10,288,677.00.

The possibility of losing 10 million dollars every year is staggering in an area that the New York State Department of Labor Research analyists estimate has a per capita income of $5,139.00 and the highest unemployment rate in the nation of 13.5%--Year round average.

A marina operator in Saranac Lake told me he would lose $50,000 per year if there were no fish in Lower Saranac Lake. There are four marinas in Saranac Lake.

The publicity that the acid precipitation battle is generating is effecting our economy. A New York State representative promoting hunting and fishing in the Adirondack Park at a recent Sportsman's Show in Harrisburg, Pennsylvania was asked why he was attending, "we heard all of your fish are gone." Many visitors who come to the local "I Love New York" Tourism Office ask, "are there any lakes that have fish in them?" Other visitors who come to the Saranac Lake Area Chamber office ask if it is safe to swim in the waters? Some say they, "knew that the water killed all of the fish but would it hurt to swim in it?"

The New York State Department of Health does not help but scares the be-jesus out of people by distributing a booklet with each fishing license outlining rules and regulations, covering all aspects of fishing in New York State which, on Page Two of the booklet includes this warning: "to minimize potential adverse health impact, the New York State Department of Health recommends that you eat no more than one meal (1/2 pound) per week of fish taken from any water in the State", hardly conducive to tourist promotion.

A Saranac Lake group representing 300 area people and 30 organizations have band together to form the "Coalition of Adirondacks to Neutralize Acid Rain Inflow". Not merely a group of environmentalists, the membership is made up of fishermen, teachers, promotion groups, and the average citizen of the area. They attempt to educate the people in our area and our elected officials to the silent danger of acid precipitation.

In March of this year, the Adirondack Association, the dean of promotion groups for the Adirondack counties, unanimously passed a resolution urging the President, the Congress, the Governor, and the State Legislature to provide the leadership and funding necessary to bring about a solution to our dilemma.

In June of 1981, the New York State Senate passed a similiar resolution petitioning the Honorable Ronald W. Reagan, President, and the Congress of the United States to bring about a resolution of the acid rain precipitation problem by opposing any relaxing of the Federal Clean Air Act of 1970 which minimizes sulpher dioxide and nitrogen dioxide discharges.

Further, the State of New York is sufficiently concerned about this creeping disaster that it has petitioned the Environmental Protection Agency to stop the request from 6 states to increase their emissions and is suing 3 plants that have already been allowed to relax their standards: one in Michigan, one in Ohio, and another in Illinois.

An article in the June 8, 1981 issue of the New York Times entitled "Acid Rain in Adirondacks Disrupts the Chain of Life" says about the impact on tourism: "For every disappointed fisherman who may go elsewhere other visitors have come along." Instead of building on this multi-million dollar industry, we are standing still. We are exchanging one market for another...a no-growth approach in an area dependent upon the growth of tourism. Perhaps one day, the visitor to our area will view our beautiful crystal clear lakes and streams and listen to a tour guide tell tall fish stories about the not-so distant past when the economy of the Park was based on the sportman.

The acid rain questions will be abated for years by environmentalists and the industries most affected financially by the Clean Air Act: those who are affected the most by this abate and the failure to find a speedy answer to the problem are people such as the ones I represent, those in the middle; those without a lobby. We are innocent victims of somethin that we cannot defend ourselves against. We have no industry but we inherit the pollution of the industrial areas. We, in the middle, invite both the environmentalists and the blue and white collar worker who labors in a pollution emitting industry to vacation in the Adirondacks, so that we too can make a living.

Every publication used in the preparation of this statement came to the same conclusion: that the politican will be our savior of the Nemesis in this debate on acid precipitation. Politics is charged with mediating human choices. Sometimes you improve the status quo by doing something and other times you improve it by doing nothing. When you succeed, you expand your set course of action. The millions of tons of sulpher dioxide and nitrogen dioxide that have been cut back and are no longer contributing to the acid problem prove the success of the Federal Clean Air Act. Your choice should be simple, you can improve the status quo by doing nothing and leave thepresent Federal Clean Air Act alone or you can, faced with this success, expand the set course, strengthen the Clean Air Act and stop the death of Adirondacks lakes ~~and~~ help to preserve and build on our fragile economy.

A small Chamber of Commerce in one of this nation's most beautiful areas could be accused of having a "JAWS" mentality. We keep shifting the vacationing fisherman to lakes with viable fisheries; or, we can depend on the leadership of this nation to put a halt to this creeping ecological and finanacial disaster and set already affected areas on the road to recovery, so that the tall fish tales told will be ones experienced this morning, next week, next year, next decade.

Thank you.

Mr. **Martin**. Sue, I want to thank you very kindly. In your capacity at the chamber you might be interested in this: Yesterday morning, I met with the aluminum brick and clay workers, who were in Washington for their executive meeting, and, of course, offered to find a home for their convention. I started here and peddled my wares all the way to the Thousand Islands, and I think they are going to be having a convention, which means 600 people for 2 solid weeks, and I think it will be in Lake Placid, which will help Saranac Lake, of course.

When I was before them, I spoke of Lake Placid and spoke about the Adirondack Mountains, and sure enough, there was a fellow from the South who wanted to know if this wasn't the place where they had all the acid rain.

The problem is, as we have Congressmen from all over the Nation up here—to learn first-hand of the problem, the more we do, the more we counteract what you are attempting to do; it puts us in kind of a catch 22 situation, but I suggest we are attempting to find a solution. I know the frustration it must mean for you, because the more we talk about it, the more people know about it, and the more people think, "Good God, when I go up there, I am going to be poisoned?" which isn't the case.

Ms. **Dyer**. Part of my written testimony speaks to that. We have had people who have come in to ask if it was safe to swim in the water. They knew everything was dead in it, but would it hurt them to swim in it. Yes, that bad publicity is hurting us.

Mr. **Mitchell**. My question is tied in with that thinking. I wonder whether you have had any decline in your fishing industry in the last 10 years. Has it stayed at the usual level?

Ms. **Dyer**. I think it has stayed, but the point is, we will be shifting them, moving them from lake to lake.

Mr. **Mitchell**. Are you concerned that if we keep emphasizing acid rain, it is going to have a serious impact on your tourism trade? I guess you have already answered that.

Thank you, Mr. Chairman.

Mr. **Martin**. Congressman Carney?

Mr. **Carney**. I have no questions, Mr. Chairman.

Mr. **Roden**. I have attacked that same problem in my mind. I am in the resort business. Do I keep still, do nothing, or do I seek the help we have to have? I finally came to the conclusion that we had to go outside to you people because you can take care of it. We can't. We have to run that negative publicity risk.

I really think we have to run that risk and get the most publicity we can on the acid rain disaster we have in our beautiful Adirondack Mountains.

Mr. **Martin**. My point is that the situation is bad enough. But by the time it gets spun from person to person for a while, we come down to the question, "If it is poisoned, can I swim in the lakes?" Certainly they can swim in the lakes. That is a problem that Sue has and I know she faces every day.

Mr. **Mitchell**. It seems the way we solve problems in America is when we develop a large public awareness, so I think we have to talk about it and make it highly visible, there may be a short negative impact as people are concerned, but the more we educate them, I think there is less damage from that, and it is more likely we are going to do something about it.

Ms. DYER. That is very true. We agree with that.

Mr. MARTIN. Mr. Sensenbrenner?

Mr. SENSENBRENNER. One very quick question: I know this area has gone heavily into advertising since the "I Love New York" campaign started out a couple years ago.

Can you tell me what the impact has been on tourism since the "I Love New York" campaign began, and what percentage of this area's "I Love New York" funds have been devoted to showing everybody how great the fishing is?

Ms. DYER. I can't give you exactly the increase in tourism. If Betsy Boyd is in the audience, perhaps she can. She said she was coming back this afternoon.

I will certainly make those figures available to you because they are documented and updated and have been ever since the program began.

I think it has certainly made a great impact on our area.

Let me go from a wide range back to a small chamber in a small town. Let me tell you where it has helped us. We are able to double our advertising funds and for a small town with 6,500 people, you can certainly see that we are not able to generate a large advertising dollar from the membership.

We depend on municipal funds and village funds to augment membership funds for advertising, and yet we still are very marginal in the amount we can spend. So, when the matching funds program came along, in particular, that was a direct allocation to local areas through their counties, so that, for every dollar we would spend on advertising, they would give us a dollar; so that we have a 200 percent impact. That has helped all of us.

The greater awareness through the "I Love New York" campaign on the Adirondack region has certainly helped. I will send you all those figures—I do not have them here.

[The information Ms. Dyer provided for the record follows:]

RETURN ON INVESTMENT—INCREASE IN TRAVEL AND TAX REVENUES, 1977–80

[Calendar years]

	Amount (millions)	ROI
Dollars invested	$31.7	
Resulting incremental travel revenues	2, 033.7	64:1
Resulting incremental tax revenues	250.2	8:1

Mr. SENSENBRENNER. Part of your testimony was devoted to the actual impact of the fishing industry on the tourist trade, and you referred to the number of fishing licenses sold in the region, and the like.

How much of your "I Love New York" funds have been used to promote the fishing that exists up here and to attract people to come and fish in lakes in this area?

Mr. MARTIN. I think those are included in the figures Ms. Dyer said she would provide.

Ms. **Dyer**. Do you mean what the State spent or what the Saranac Chamber spent?

Mr. **Sensenbrenner**. If there is an ugly rumor going around that acid rain has made all the lakes unfishable and that is not true, it seems some of the "I Love New York" funds can be used to dispel those ugly rumors.

Ms. **Dyer**. Perhaps when you come back on vacation, you will buy a fishing license. The booklet they give you says, "Please don't eat more than a half a pound of fish taken in any stream in New York State in more than a week."

How would you like to buy a fishing license that carried a warning like that? "Have fun fishing. Just don't eat more than a half a pound a week." So we are having a tough time convincing our own State to temper that a little bit.

Mr. **Sensenbrenner**. My question is how much of the pollution is caused by acid rain and how much is caused by other kinds of pollution? I know we have a problem in Wisconsin with various kinds of things we are trying to get a handle on, both through national regulation as well as State regulation, and we have something of a problem like that in our State as well, but I am certain it is nowhere near as severe.

I will just reiterate my concern that maybe you are not spending enough of your advertising dollar keeping that fishing industry attraction going.

Ms. **Dyer**. Perhaps you are right.

Mr. **Carney**. I would like to just point out something that I think we are seeing happen right here and now, and that is the problem that we have, more specifically, Dave Martin, Jim Scheuer, and Don Mitchell and myself, of coming from New York. We have to make a national awareness of the problem the Adirondack region has, and we have to show them this is of national concern, not a State concern.

The problem that we are faced with is that Jim Dyson would come down to Washington and say, "My God, this 'I Love New York' campaign is the most effective thing we have ever done to enhance our tourism program in the State of New York." Tourism has improved in the State of New York since its initiation.

We are doing a great job here. New York State is doing its share; you are doing your share in the chambers of commerce. The "I Love New York" campaign is a great success.

That is just a holding action. If we lose any more than what we have lost already up here, all the "I Love New York" campaigns in the world aren't going to get people back in this region. It is very difficult. I can understand Jimmy's questioning, because on September 23, when we have our New York State festival, we are going to brag about how great the fishing is in this region, and then the rest of our colleagues are going to say, "What are you complaining about?" We have to identify it. That is why we have to rely on a scientifically-produced data base to point up the sources of pollution.

You are right. We have to continue to do what we are doing. We have to continue to fund studies, and we have to start taking remedial action that we know of now and can afford to implement right now. None of it can stop, or we are going to be in a lot of trouble.

I think, Jim, in all due respect to the questions you are asking, I know about it first-hand.

Mr. **Sensenbrenner**. If I can reclaim my time as the only Member of Congress here today that does not represent New York State—now that Mr. Gregg has gone back to New Hampshire—earlier today, there was testimony to the effect that my State has got the best State level acid rain investigation program in the Nation. It is funded by State tax dollars and a contribution by utilities. So every time I pay my electric bill in Wisconsin, I am helping to fund that study. We are trying to get an answer to the problem of acid rain which is nowhere near as severe a problem in northern Wisconsin as it is here in the Adirondack region of New York.

I am just tossing it out that perhaps while the concern is here among State and local officials, perhaps the commitment is not matched by the concern in terms of State tax dollars actually going into solving that problem.

Mr. **Carney**. We have paid the highest rates for the generation of electricity, for two reasons. First, our air is so polluted from sources of pollution not within New York State, that the EPA mandates that we maintain the highest quality of technology on our utilities. Second, we don't have the ability to burn the cheap high sulfur gas that is polluting New York State. We rely very heavily on foreign oil.

Mr. **Sensenbrenner**. The reason electric rates are lower in Wisconsin, which does not have ready access to coal, is that over 40 percent of our power is generated from nuclear power facilities, and that is the cheapest way to generate electricity on a per-kilowatt basis; so maybe one of the reasons that New Yorkers are paying more for their power is due to actions of the State government in deciding what kind of a mix of electric-generating sources you have.

Mr. **Carney**. Mr. Chairman, I would just like to say no matter what he says, New York cheese is better than that of Wisconsin.

Mr. **Martin**. I would hesitate to continue a discussion of cheese. For your information, Mr. Sensenbrenner, as Mr. Fink said before, we do have some problems upstate and down-state in the State of New York as far as power rates are concerned, and if we were to continue that discussion, it would probably begin to look like Anzio beachhead around here.

I want to introduce Dennis Conroy, of the Upper Hudson Environmental Action Committee, an organization that has been in existence for better than 10 years now. Mr. Conroy is from Wevertown, N.Y.

Mr. **Conroy**. I will just make a few comments that have not been made.

I represent people in the southeastern part of the park, and I think it is safe to say that outside of unemployment, this is probably the item that they are the most concerned about.

What is the impact in—well, there are 9 million tourists who come into the park each year, and many of the permanent 215,000 residents depend on these tourists for livelihood—storekeepers, motel operators, guides, restaurant owners, people who sell bait.

We have emphasized, I think, on the panel, the impact on fishing, but as Ann indicated, there is a broader tourism impact, we believe, for when fish die, birds and animals leave that area; and around the dead lake, you can't hear birds; you don't see herons, kingfishers; the kids can't catch salamanders; campers can't hear the loons; canoers can't see ducks; trappers can't catch fish and others. These are all environmental impacts which will affect tourism if it continues.

Right now, perhaps we have 6 or 7 percent of our lakes and ponds sterile, or maybe up to 10 percent, but we believe that this problem is increasing, and that something can be done about it. The United States pumps 28 to 30 million tons of sulfuric oxide into the air every year and about 24 million tons of oxide nitrogen. The technology exists to do something about that.

My figures on Japan are that from 1970 to 1975, Japan cut their pollution 50 percent while their electric generation increased 120 percent. They installed about 1,000 scrubbers. The last figures I have for the United States is that we have 78 scrubbers installed in 30 plants and about 38 are being built. We think that is the problem.

We know in some plants like Louisville Gas & Electric in Kentucky, they are removing 85 percent of the sulfur dioxide before it goes up the stack, and without great cost to consumers.

One thing I would like to mention is that I have seen concern over the sludge that comes from scrubbers. Louisville has developed a clay-like substance which they make from combining the sludge with fly ash, which is another byproduct of the electric generation plant, and carbide wastes they get from chemical plants. This makes a chemically-bonded substance. It can be used in many ways. You can make hills out of it; you can make roadbeds; you can use it for flood walls, or you could fill up old mines with it. There isn't a waste that is a problem to dispose of if it is combined in that way.

We would like to see the installation of these scrubbers in new plants and require installation in old plants as well.

The present Clean Air Act does not do it. We would like to see the Clean Air Act extended. We believe the costs of installing these improvements should be borne by the emission sources with the costs passed on to the products. We urge the subcommittee to strengthen the provision to limit the emissions.

It is a beautiful wilderness area. We are concerned that we are in danger of losing it if something is not done on a national basis.

Thank you.

[The prepared statement of Mr. Conroy follows:]

UPPER HUDSON
Environmental Action Committee
BOX 82, WEVERTOWN, N.Y. 12886

September 18, 1981
Lake Placid, NY

STATEMENT OF DENNIS CONROY

PROJECT LEADER--ACID RAIN

The Upper Hudson Environmental Action Committee appreciates the opportunity to express our position on the problem of acid precipitation to the Subcommittee on Natural Resources, Agriculture Research and Environment.

We are an organization in the southern portion of the Adirondack Park, whose aim is to initiate and support action for protection and improvement of the total environmental system. Clean air and safe water are essential elements in preserving the quality of our life. Yet, today, these irreplaceable natural resources are threatened by a silent peril coming from the sky; rain, snow and fog laced with acidity.

We have studied much of the expansive literature and research available. It is true that atmospheric scientists are not able to tell us exactly how the chemical processes occur which result in sulfur dioxide and nitric oxide laden with precipitation. But it is also true that the problem has been constantly growing from the first faint signs of acidic impact on lakes that were recognized as early as the 1950s. Big Moose Lake, Lake Colden, South Lake were paradises for anglers in the 1930s;today they and at least 180 former Adirondack brook trout ponds are devoid of fish.

Some people point out that acidity in rain and snow is a natural process and has always been present. This is true but man-made pollution from industry, electrical power generation, and internal combustion engines has increased the amount of acidity from 10 to 40 times more than nature planned. There is broad agreement that acid rain in most of our northern hemisphere is caused by anthrogenic emissions of sulfur dioxide and, to a lesser extent, oxides of nitrogen. The U.S. pumps 28 to 30 million tons of sulfur dioxide and 24 million tons of nitric oxide into the air each year. The Global 2000 report indicates that 140 million tons of sulfur dioxide are sent aloft each year by all countries. This pollution comes down and is causing our problems where soils can no longer buffer the impact.

What is the extent of the impact on the Adirondacks? Nine million tourists visit this area annually. Many of the permanent residents (storekeepers, gas station operators, craftsmen, hotel operators, guides, restaurant owners) depend on income from tourism for their livelihood. And when fish die, birds and animals leave. Around the dead lakes one cannot hear spring peepers, hikers cannot see herons or kingfishers, children cannot catch salamanders, campers cannot hear the mournful wail of loons, canoers cannot enjoy seeing fish-eating ducks, trappers cannot catch mink and otter. Fortunately only 6 or 7 percent of our lakes and ponds are now sterile but our "forever wild" area is within the reach of millions of tourists, and the remaining ponds should be saved.

Acid rain also causes corrosion of buildings,bridges,water systems, machinery and vehicles. The potential health impact of increasing acidity gives us great concern. Low pH levels in water leach metals such as aluminum from rocks,polluting drinking water. Leaching of lead solder in water pipes has also occurred.

Finally, although there is not enough information to say exactly what the affect on tree growth might be, one study indicates acid precipitation may be responsible for accelerating the leaching of nutrients from forest soils and changing the character of soil organisims--and the timber industry is one of our largest employers.

Some propose short-term solutions to the problems such as liming lakes. This process is expensive, must be repeated often and has no impact on leaching of metals or changes in soil chemistry. The omly permanent solution is to keep acid rain levels low by reducing emissions at the source. The technology exists. Up to 90 percent reduction in coal burning plants can be made by installing chemical scrubbers. These flue gas desulfurization systems have been used effectively in the past where emissions have been reduced overall to 50 percent. Scrubbers are already being used in the U.S.; the Louisville Gas and Electric Company in Kentucky,for instance, is removing 85 percent of sulfur dioxide before it goes up the stack. It has a biproduct, a claylike substance called pozotec, which can be used to make bricks, build roads and to fill abandoned mines.

The Upper Hudson Environmental Action Committee believes the problem of acid percipitation is growing--affecting not only the Adirondacks but large sections of the northeast, and parts of the middle west and the western parts of our country. The social and economic impact is already being felt and the potential for a more serious impact will occur as emissions increase.

The cost of remedies should not have to be borne by people who are not causing the problems. The need is to continue to legislate the installation of these scrubbers in new plants and also require installation in old plants. The cost of installing these improvements should be borne by the emission sources who will pass along part of the cost to consumers of their products.

We urge the Subcommittee and Members of Congress to introduce legislation to extend the Clean Air Act and strengthen the provision to limit emissions on all plants. Until this happens, and scrubbers are installed, increasing areas of our natural resources--on which so many depend for a livelihood and a wilderness experience--will fall deadly silent, not just in the Spring but during all seasons.

Mr. MARTIN. Are there questions?

Mr. MITCHELL. Were you here for the testimony this morning, Mr. Conroy?

Mr. CONROY. Yes, sir.

Mr. MITCHELL. Did the testimony from the scientific community deter you at all in your desire to get started right now? Are you convinced there is something we can do that will help the situation enormously?

Mr. CONROY. I have worked with scientists for about 25 years. Most of them are agricultural scientists. They never want to say that something is perfected or that they have the final answer: It is the nature of the person.

Mr. MITCHELL. It is the nature of the discipline, too, is it not?

Mr. CONROY. Yes.

I felt there was an inconsistency in the testimony this morning. It seems to me if they don't know whether 50 percent is going to have an impact, then certainly you don't want to do just a little bit and wash coal and use the cheap stuff. You probably want to go into a major program.

If, in fact, it is not going to help the Adirondacks for a while, I don't mind helping the Canadians or the people in Maine. This is a global problem, and I think we have got to reduce sulfur dioxide and oxide emissions. We have to start sometime soon. It is getting very late. It takes time to start the action. If we don't get started soon, everything may be lost.

Mr. MITCHELL. You have heard scientists testify in a more positive way that it would be helpful to start right now. Have you heard any testimony from scientists to that effect, or do they always want to perform more studies?

Mr. CONROY. I think the fisheries scientists think we ought to start right now.

I have read most of the points that were made this morning previously, and we have discussed these in our committee. They were not convincing to me.

Mr. MARTIN. Are there further questions?

I want to thank the panel very kindly. Any written remarks you have will be entered into the record.

Again, we appreciate your being here.

Mr. MARTIN. The next panel we are going to have is Theodore Ruzow, the chairman of the Adirondack Park Agency, and Mr. Bowes, who is a lifelong resident of the Adirondacks and is the owner of a lodge on an Adirondack lake. It is very interesting. He has experimented quite extensively as far as the liming is concerned. I think we will find that very interesting.

Also, Mr. Harold Hughes, from Potsdam, N.Y. and Clarence Petty, a long-time constituent of mine from Canton, N.Y. I want to remind the panel that we are short on time. We would appreciate your attempting to highlight your comments.

STATEMENTS OF THEODORE RUZOW, CHAIRMAN, ADIRONDACK PARK AGENCY, STATE OF NEW YORK—EXECUTIVE DEPARTMENT, RAYBROOK, N.Y., C. V. BOWES, COVEWOOD LODGE, BIG MOOSE LAKE, EAGLE BAY, N.Y.; DR. HAROLD K. HUGHES, VICE PRESIDENT, ADIRONDACK ASSOCIATION, INC., POTSDAM, N.Y.; AND CLARENCE PETTY, CANTON, N.Y.

Mr. RUZOW. Thank you, Congressman Martin, and members of the panel.

Mr. Chairman, I appreciate the opportunity to present the views of the Adirondack Park Agency to the Subcommittee on Natural Resources, Agriculture and the Environment.

My name is Theodore M. Ruzow. I am the chairman of the Adirondack Park Agency, an independent part of the executive department of the State of New York. The Adirondack Park Agency is responsible for regional land-use planning and development regulation of the private and public lands of the Adirondack Park. We are charged by our statute with "responsibility for developing long-range park policy in a forum reflecting statewide concern." The agency is a member of the NYS Interagency Task Force on Acid Precipitation chaired by the New York State Department of Environmental Conservation.

I am here today to emphasize the Adirondack Park Agency's concern that the Adirondacks not become a dumping place for the atmospheric pollution known as acid precipitation.

The Adirondack Park is an area of about 6 million acres, or about the size of the State of Vermont. There are 3.7 million acres—about 60 percent—of private land in the park and 2.3 million acres—about 40 percent—of State-owned "forever wild" lands protected by the New York State constitution as the New York State Adirondack Forest Preserve.

The Adirondack Park is the permanent residence of approximately 125,000 individuals. Some 9 million tourists visit the region annually. Employment is heavily dependent on tourism, the forest products industry, mining and other service industries.

I wish to make four points regarding the subject of acid precipitation in the Adirondacks:

First, the Adirondack Park Agency was the first agency of the State of New York to draw attention to the policy implications of acid precipitation in a position paper released in 1975. While we are not responsible for primary research into the effects of acid precipitation, we have followed the research of others with obvious interest and concern.

We vigorously supported Federal legislation, passed as the Acid Precipitation Act of 1980—title 7 of Energy Security Act of 1980, Public Law 96-294—and have consistently called for protection of the fragile ecology and economy of the Adirondack Park from the long-term degradation acid precipitation brings. I reaffirm that position today.

Second, the Adirondack Park is an area of vast resources, and relatively few people. The fact that our resources are under-represented in Washington should not be taken as an invitation to use the Adirondack Park as a dump for the Nation's long-range atmospheric pollution. This is a problem for Federal action. The Adirondacks are the archetype of a region of abundant natural wealth with a small political voice. We need a strong, consistent Federal policy. We do not need the State of New York pitted against the State of Ohio in protracted and costly litigation.

Third, this is a problem that demands action now. Turning acid precipitation into a political football could do as much indirect economic damage, at least in the short run, as the rainfall, itself. Misstatements in the popular press portraying the Adirondacks as "dead" or as remote and wild without people, industry, or culture, do a disservice to the people of this region who are deeply committed to maintaining the park's environmental quality.

The Adirondacks are not dead. That there are some dead lakes is a symptom of a disease that is progressing and that must be treated and arrested. The natural resources that as yet are relatively unaffected should be our greatest concern, since they continue to draw the millions of visitors to the region each year.

Fourth, the Clean Air Act must address this issue. If under the Clean Air Act, as presently implemented, the acid precipitation problems continues, then the Clean Air Act must be reviewed and materially strengthened.

The National Commission on Air Quality stated in its final report that the pollution control costs incurred to comply with current air pollution control regulations should not inhibit long-term nationwide development of any domestic energy source, particularly coal.

The economic implications of acid precipitation effects are only beginning to be explored. There is urgent need for more attention to this side of the problem as specific Clean Air Act provisions are addressed.

Clean air cannot be treated solely as a local problem or resource. Interstate and international effects should be an essential consideration toward strengthening the Clean Air Act. Congress should specifically address long-range transport and acid precipitation in this respect.

The Adirondack Park Agency—on behalf of both the citizens and the natural resources of this region—urges you to report back to your colleagues in the Federal Government on the beauty and uniqueness of this region as you have now seen it first-hand—and on the threat of acid precipitation to our economy and environment. The agency stands ready to assist you with all of the resources at our disposal.

[The position paper, "Acid Precipitation and Its Effect on the Adirondack Park," referred to and attached to Mr. Ruzow's statement follows:]

STATEMENT OF THE ADIRONDACK PARK AGENCY

ON

ACID PRECIPITATION AND ITS EFFECT ON THE ADIRONDACK PARK

May 23, 1975

THE ADIRONDACK PARK

New York State's Adirondack Park constitutes one of the last large wilderness and semi-wilderness areas east of the Mississippi. Its rugged mountains, clear lakes, tumbling streams, winding rivers and great forests cover approximately 9,000 square miles of northern New York. A major source of water for five important water systems (Black River Basin, Lake George-Lake Champlain Basin, Mohawk River Basin, St. Lawrence River Basin and Hudson River Basin) that draw from its thousands of lakes and streams, a home for an abundance and variety of plants and animals, and a land of clean air, cool summers, harsh winters, and rugged beauty, the Adirondack Park constitutes a unique natural area that also serves man's needs for natural resources, a place to live, recreation, aesthetic enjoyment and peaceful solitude. Created as a State park in 1892, the Park's lands are subject to stringent and far-reaching land use controls. The forty percent of the Park owned by the State of New York (approximately 2,300,000 acres) is protected by the "forever wild" clause of New York's Constitution. The remainder of the Park's 6,000,000 acres, owned by private citizens, corporations, municipalities, and other entities, has been governed since 1973 by the Adirondack Park Land Use and Development Plan, a regional land use plan that mandates the protection and wise use of the Park's resources and that is administered by the Adirondack Park Agency.

THE PROBLEM

Despite the protections afforded the lands and resources of the Adirondack Park by generations of New Yorkers, the Park's unique and irreplaceable resources may be seriously threatened by airborne gases (mainly sulfur and nitrogen oxides) that are discharged into the atmosphere as a result of fossil fuel combustion far from the Adirondacks. These gases are converted in the atmosphere to strong acids that eventually fall to the ground as acid precipitation ("acid rain"). Acid precipitation is making many Adirondack lakes unsuitable for the survival and propagation of fish and other aquatic organisms and may be a threat to vegetation and soil resources in the Adirondacks.

The acid precipitation phenomenon is exceedingly complex. It is difficult to determine the exact geographical location of sulfur and nitrogen oxide emission sources that cause problems in the Adirondacks, the manner in which these pollutants are mixed with and transported by the atmosphere, and the actual mechanisms by which these oxides are converted in the atmosphere into sulfuric and nitric acids. There are substantial questions regarding the feasibility of using existing technology and other power sources to control these emissions. Impacts of acid precipitation on water quality and fish populations have been studied in several locations, including the Adirondacks. Specific impacts on soils and vegetation have been defined to only a limited extent. The nature of the impacts caused by acid precipitation on economic and social values are at the present largely unknown.

Based on the information now available, it is clear that acid precipitation has already severely damaged a portion of the Adirondacks' resources. Due to the low acid neutralizing (buffering) capacity of many bodies of water in the Park, fish populations have declined, disappeared or become endangered in 11,546 acres of Adirondack lakes and ponds at elevations of 2,000 feet and greater primarily because of acid precipitation. Two-thirds of the lakes in five State Wilderness areas in Herkimer County (Five Ponds, Pigeon Lake, Pepperbox, West Canada Lakes, and Ha-De-Ron-Dah) are chemically unsuitable for the survival of fish. Adverse effects on other aquatic organisms and ecosystems are also occurring. Although Adirondack plants and soils presently appear capable of neutralizing acids introduced by precipitation, their capacity to continue doing so is unknown. While no decreases in forest production in the Adirondacks have been documented, undesirable reductions in plant growth may eventually occur in the Adirondack Park unless the acid precipitation problem is solved.

The physical and biological impacts of acid precipitation on Adirondack resources may cause substantial negative economic and social losses in the Adirondacks. Recreational losses due to the decline and disappearance of fish populations is already occurring. Declines in the growth of commercial forest timber, reductions in maple syrup production and losses of agricultural crops, if they occur, may seriously aggravate the economy of an already economically depressed area.

The degradation and loss of the quality of Adirondack resources constitutes a social cost that cannot be measured. The bountiful resources of the Adirdondacks contribute in large measure to the physical and emotional well-being of countless persons throughout New York State and the eastern parts of the United States and Canada. The destruction or serious degradation of these resources would remove a vital link from the environmental fabric that is essential to the preservation of man's well-being.

There is substantial evidence that the major sources of the pollutants causing the acid precipitation problem in the Adirondacks are motor vehicles, and industries and electric power plants (especially coal-fired plants) located in the midwest and northeastern United States and southeastern Canada. Power plants discharge quantities of sulfur oxides and motor vehicles discharge quantities of nitrogen oxides into the atmosphere. Sulfur oxides, retained in the atmosphere for an average of two to four days, and nitrogen oxides are carried in a generally easterly direction before being deposited as acids. The nation's enormous consumption of fossil fuels, its reliance on motor vehicles, the existing shortages of oil and natural gas which will necessitate heavier reliance on coal as an energy source, and the expected increases in natural energy consumption all mean that the present acid precipitation problem in the Adirondacks may become further aggravated unless solutions are found.

The amount of pollutants, particularly sulfur, being introduced into the atmosphere by fossil fuel power plants can be controlled at the present time by two primary methods: 1) burning low sulfur fuels and 2) removing oxides from gases after combustion by means of flue gas desulfurization systems (scrubbers). Because low sulfur fuel is not available in sufficient quantities to serve the nation's power needs, the use of scrubber technology is necessary to control the acid precipitation problem. Various technologies have been tested to control nitrogen oxide emissions from motor vehicles.

The solution of the acid precipitation problem in the Adirondacks is directly related to the successful implementation of the existing provisions of the Federal Clean Air Act, administered by the United States Environmental Protection Agency. The Clean Air Act requires the protection and enhancement of air quality and establishes national ambient primary (necessary to protect health) and secondary (necessary to protect the environment and social and economic values) standards for various pollutants, including sulfur and nitrogen oxides that contribute in large part to acid precipitation in the Adirondacks. States must prepare State Implementation Plans that provide for the attainment of national primary standards by 1975 (or 1977 in some instances) and of secondary standards within "a reasonable time" by means of emission limitations on air pollution sources. The Environmental Protection Agency establishes regulations for pollutant emissions by new motor vehicles.

As part of the Energy Independence Act of 1975 the Ford Administration is proposing amendments to the Clean Air Act that could delay for a number of years the compliance schedules now required by the Clean Air Act for existing sulfur oxide sources to comply with emission limitations. These proposed amendments include relaxing the requirements for granting variances to compliance schedules, allowing certain existing plants to avoid existing requirements for installing scrubber technology until 1985, and relaxing the emission control requirements on existing power plants switching from oil or gas to coal. Furthermore, the Administration's proposal would delete the Clean Air Act's existing proscription against the significant deterioration of existing air quality, a proscription that is of vital importance to clean air areas like the Adirondacks.

Finally, the Energy Independence Act of 1975 would amend the Clean Air Act's existing schedules for reducing new car emissions by freezing for five years nitrogen oxide emission limitations to those required for new 1975 models. Any of these amendments have the potential of aggravating the acid precipitation problem in the Adirondacks.

RECOMMENDATIONS

The Adirondack Park Agency makes the following recommendations regarding the acid precipitation problem in the Adirondack Park.

1. National primary and secondary ambient air quality standards for sulfur and nitrogen oxides and State implementation plan emission limitations for sulfur and nitrogen oxides established under the Clean Air Act should be achieved at the earliest possible date to guarantee the protection of public health, the environment, and economic and social values.

2. Any relaxation in the Clean Air Act's existing provisions and in State implementation plan provisions relating to the control of sulfur and nitrogen oxides and to the maintenance of existing air quality should not be made without a full and careful assessment of the regional, environmental, economic and social impacts of such changes on rural areas, including the Adirondack Park, likely to be affected regardless of the distance from the sources.

3. Federal agencies, including the Environmental Protection Agency, state agencies and other entities should perform the research efforts necessary to fully assess the sources, formation, distribution, effects and short term and long term control of the acid precipitation phenomenon. New York State's Department of Environmental Conservation should expand its studies regarding this phenomenon and especially its existing research efforts within the Adirondacks. All of these research efforts should utilize the sensitive resources of the Adirondack Park as an "early warning system" to assess the impacts of acid precipitation on natural resources in the northeastern United States.

Mr. MARTIN. I thank you very much.

Are there any questions?

Mr. CARNEY. I appreciate the testimony. I would just like to say one thing. I know you didn't mean what I might have heard. I think you have a very loud voice in the Congress and very effective. That is why we are here today. Dave Martin is a new man on the scene. We are up here because he has demonstrated his concern, and the chairman knows of the concern. The fact that you have one person for a large region, I think that is significant, but Dave's voice is loud and Dave's voice is clear, and I would just like to have that on the record at this time.

Mr. MITCHELL. Your testimony would seem to run counter to the testimony of the scientists. Your recommendation is for action right now. Do you care to make any observations on the testimony that our scientific community provided?

Mr. RUZOW. I was not here this morning, but I have read a great deal of scientific testimony. I think that kind of testimony could go on forever. The research could continue forever, and they could not ever reach a point in time where all scientists or most scientists were uniformly agreed on final ultimate conclusions.

On the other hand, I think the problem is much more simple than we have made it. I don't think it is exclusively a problem of acid precipitation or acid rain. It is a personal view. I think it is a problem and an issue of clean air.

Wherever you go in this country, and I travel quite a bit, you see pollutants affecting the air. You know that you are doing great and irreparable harm to 235 million Americans. Not simply 300 lakes in the western part of the Adirondacks, but you are doing harm to the health and the well-being of the health of the people in this country. We must not permit these pollutants to enter the air.

I realize you can't conceivably prevent all of them from entering the atmosphere, but you can materially reduce the quantity on a nationwide basis, deferring dealing with the problem until you can get the cooperation of Canada, Japan, the Soviet Union. That means you can never deal with the problem. You can deal with it as the Congress of the United States of America by, in my judgment, strengthening and enhancing the Clean Air Act that now exists.

Mr. MITCHELL. Thank you, Mr. Chairman.

Mr. **Sensenbrenner.** One of the witnesses in the previous panel seemed to indicate that at least a part of the Clean Air Act is a part of the problem, and that part of the Clean Air Act requires the coal-fired plants in the Ohio Valley to have higher smokestacks so there would be less air pollution in the immediate area where the powerplant is located. Do you concur with that view?

Mr. **Ruzow.** It is my understanding there is a dispersal of whatever solid pollutant emanates from the stack. That would simply mean that the air transport of pollutants would go further. I don't know that the elevation of the height of the stack is the solution. I think the solution lies in making certain that whatever comes out of the stack is kept to a bare minimum, and the closest thing to a bare minimum, of course, is zero, but it is not feasible to expect no pollutants will enter the atmosphere, but I do believe that is the solution. If it doesn't go up in the atmosphere, it doesn't come down—whether it is in Wisconsin or in the State of New York.

Mr. **Sensenbrenner.** We have all heard the argument about the cost-effectiveness relationship of scrubbers and the like. As a short-term real cheap answer to the problem of acid rain in the Adirondacks, would you be prepared to lower those stack height requirements that were part of the regulations promulgated after the Clean Air Act was passed? In other words, those who live in the neighborhood of the powerplant and get electricity from the powerplant ought to bear the brunt of the solution.

Mr. **Ruzow.** I don't want to be that parochial or partisan on a geographical basis. I think the problem is, there are 235 million people in this country who are entitled to protection from pollution, and I think trying to make a game out of the pollutants as if they were a football and moving them west or east or north or south doesn't solve the problem.

Mr. **Sensenbrenner.** I think it is obvious from previous testimony that when the Clean Air Act heightened the smokestack heights in the Ohio Valley, that is when the real acid rain crunch came in the Adirondack region, and that this might be a case of a Government regulation having an unintended adverse effect someplace hundreds of miles away from the source of the pollution itself.

I agree with you we ought to get down to as close to zero as possible, and I think that is one of the things that is going to be considered at the time the Clean Air Act reauthorization comes up. But the point I am trying to make and that I am trying to get you to agree to is that sometimes these Government regulations, when you try and do something in one area of the country, the shoe drops off in the other area of the country, and I think the shoe has dropped on your head.

Mr. **Ruzow.** I would just respond, Congressman, by saying that that only is an indication perhaps of failure to completely understand the consequences of both laws and regulations. I think that is more in your bailiwick as a Congressman than it is in mine, but I do think it is a national problem, and I don't think it is limited simply to acid precipitation in the Adirondack Park. I think the problem has to be addressed by the Congress because that is your function.

I think whether you talk about raising stacks or lowering them, the answer is, if you check or test or measure or modify what comes out of the stacks, that is what determines what program is successful or not. Then you are not concerned with whether it drops in the immediate vicinity of the stack or 300 miles downwind.

Mr. Sensenbrenner. I don't represent either Ohio or New York. Perhaps I can view this problem in a little more objective manner. We all know cleaning up the emissions that come out of those stacks, regardless of what the height of the stacks is, is going to cost money, and the money is going to come from one of two places. It is either going to come from the citizens' pockets as a result of increased taxes at the Federal or State level, or it will come from the citizens' pockets when they pay their electric bills.

Now, the way the Clean Air Act has worked at the present time on acid rain, it is a real nifty arrangement because the citizens of Ohio get lower electric rates and the citizens of New York get Ohio's pollution.

Now, it seems to me the way to get the political pressure on so that Ohio would be cognizant of its responsibility not to dump all this junk into the air is to have them see what the effects of the junk are in a little more concentrated and a little bit more graphic manner, and then the people of Ohio would probably put the pressure on their Members of Congress to join with us rather than fighting against us.

Mr. Martin. Can I conclude that Mr. Bowes cannot be with us? I am very disappointed, but I did want to point out that the written remarks he has sent to us, without objection, will be entered into the record. He is experimenting with liming of the lakes, and I wish the members here had an opportunity to hear him and question him.

[The prepared statement of Mr. Bowes follows:]

Covewood Lodge
Big Moose Lake, N.Y.

JUN 23 1981

SEPTEMBER 18, 1981
LAKE PLACID, NEW YORK

The Effects of Acid Rain on Big Moose Lake
submitted by: C.V. Bowes, Jr.

With the exception of the war years, 1941-46, I have spent part of every year of my life in the Adirondacks, as my father and grandfather before me. One of the earliest memories I have is of my father taking me in a back pack to go fishing in some of the remote lakes near our camp. Even then, in the early 1920's, fishing was better in some lakes than in others, but all lakes had some fish. Then the fishstarted completely disappearing from some of the lakes. At this point no one spoke about acid rain, but blamed the poor fishing on the beaver, lumbering and storms that blew down large stands of evergreens. At our hotel, those guests that used to come to fish stopped coming and were replaced by others who had different recreational interests.

Slowly it became apparent that the problem was greater than just a decline in fishing and we realized that the total environment of the area was undergoing frightening changes. We no longer have Osprey, Loon and Kingfisher nesting on the lake. The otter and Hooded Merganser no lon feed on crayfish in the outlet of the lakes because the crayfish have disappeared. It is believed that their shells, made of calcium, are being eroded by the acid water. Our lake which once supported native trout, freshwater shrimp, caddis fly and a whole ecosystem was becoming sterile and void.

All of this was alarming to us. We have spent our lives working in the natural history field, conducting natural history tours as well as operating a hotel. Our interests are in the environment and we are therefore very aware of our natural surroundings. All of the above mentioned alarm signals were a concern, but it took our two children to bring home the seriousness of the situation. They started complaining about feeling sick when they got up in the night for a drink of water. We had repiped our hotel in 1978 with new copper pipes to eliminate the problem of rust and had noticed that since that time we had blue stains in the sinks and tubs. We asked the New York State Health Department to run a check on the water. The results were shocking. Water that had been standing in the pipes was found to have 5 times the recommended levels of lead and 3 times the recommended level of copper! The hotel water comes from a spring that has supplied delicious, pure water for over 60 years. Now it would appear that the Ph of this underground spring had dropped to such a level that the acidity was causing the metals to leach out of the pipes into the water.

Covewood Lodge
Big Moose Lake, N.Y.

The ramifications of the acid rain continue to show up. In the fall of last year our 10 year old, $20, 000 sand-filter sewrage system stopped working. Immediately we called the engineer who aided in its construction and asked him what could have caused the breakdown. The system works on the principles of filtration and aerobic bacteria decomposing the wastes. In discussing the sand filter we mentioned the problem we had with the water and he asked if there could be any copper in the water. When we told him of the results of the lab tests he knew the cause at once. Copper kills aerobic bacteria! So, in fact, the water with its leached out minerals had caused the entire system to breakdown. At this point we realized we had to restore the Ph of the spring to a more neutral level. After considerable consultation, investigation and trial and error we were able to build a contactor (a large box with compartments filled with limestone) and install it in our spring. The results have been excellent with the Pb now at about 7. Dr. Charles Driscoll of Syracuse University and some of his graduate students have volunteered to moniter the project and have performed many interesting tests comparing the treated spring water with another of our springs that is not treated. All the results show that everyone must be concerned about the problems of acid rain and its effects on the environment and our health. The majority of the property owners on Big Moose Lake drink the lake water which has an average Ph of 4.5. Those with springs have found that they are now as acid as 4.5 to 5.5. We have an idea of what this acid water does in copper pipes, leaching out harmful metals, but what does it leach out of plastic PVC pipe which is used in many homes? What long term effects will it have on our health? What of the damage done to the pipes themselves? People with relatively new pipes are having pin hole leaks appear. What of boilers, washing machines and every other piece of equipment? The breadth of the problem is immense.

During the course of investigating the spring water we spoke with numerous individuals at Cornell, Syracuse and Dartmouth college, as well as environmental engineers and Health Department officials. Anyone we could find involved with acid rain we contacted. One of these contacts led us to some reports put out by the Swedish Government detailing their research on lake reclamation. We read with interest of their failures and successes. At this point we envisioned the possibility of somehow saving our lake. The DEC (Mr. Blake) said that the state would not be able to assist us, but he did give permission to go ahead with the project. Again, Dr. Driscoll and his graduate students offered their assistance in monitering the experiment.

The project consisted of treating a relatively isolated bay of the lake (North Bay) with 35 tons of limestone dust. This was manually shovelled on a barge and then shovelled into various spots in the bay. We chose this area of the lake because it has minimal water exchange with the lake, is fairly accessible, had a good sandy bottom and most importantly had a Ph of between 4.5 and 4.9. In addition, it was found to have large quantities of dissolved aluminum. After the initial treatment the Ph of the bay improved dramatically, to almost 6, but the improvement lasted only about 3 months. The environmental engineers have discovered that we are faced with not only the problem of trying to offset the acid rain that keeps falling, but of having to counteract a bottom layer of sediment that is also very acid. They theorize that once the bottom layer is neutralized it will take smaller periodic applications of limestone to maintain an acceptable Ph level. Since all the neutralizing buffers have been leached out of the soil, it would seem that these applications will be needed indefinitely. Although we face the realistic fact that we, as private citizens, have little hope of seeing our entire lake reclaimed, we hope to have at least one small part that will support fish and the resultant ecosystem.

In summing up, I would like to re-emphasize the severity and magnitude of this issue. For every problem we have personally encountered there must be many more. The impact of acid rain is one which makes itself known in small and insidious ways, yet the final result must be catastrophic. If one could show large scale immediate impacts, such as the wiping out of the forestry industry or attributable deaths, perhaps the "powers that be" would move to correct the problem before the ultimate damage has occurred. We fear, however, that just because of its creeping, insidious nature, the acid rain issue will be "put on the back burner" to be studied, and discussed but not resolved. Did we learn nothing from our dealings with DDT? Must we be listening to the "Silent Spring" before someone will act?

Mr. MARTIN. We will move along to Dr. Harold Hughes, who serves as chairman of the Energy committee. This group represents 13 counties in New York State, and they are very much interested in the preservation of the economy, as well as the ecology of the area, and I want to point out that I have worked very closely with Dr. Hughes in the past, when he was an outstanding chairman of the St. Lawrence County Chamber of Commerce, and I think he and I can whisper that we have done some kind of innovative things from time to time.

Mr. HUGHES. Thanks a lot, Dave.

As ex-president of the county chamber, I would like to refer to the remarks of Mr. Carney, who asked about whether we are promoting fish.

We have put out a nicely illustrated book on fishing in St. Lawrence County, as nice a book as you will find anywhere. We have distributed it rather widely, and if anybody, including yourself, would like to give me a dollar, I will send you a copy. It will show you all the places to go, what lures to use, and the like.

Mr. CARNEY. If I might, it was Mr. Sensenbrenner who asked that question. I keep two things close to my heart, and that is my voting card and my New York State fishing license.

Mr. SENSENBRENNER. If the gentleman from New York would yield, I will be glad to send you a book on where you can fish in Wisconsin, free.

Mr. HUGHES. You know, Congressman, I have to admit while the New York cheese is better than Wisconsin cheese, once a month we get a carboy of liquid nitrogen which includes 30 little starters of Wisconsin cheese, and that is where we start.

Mr. SCHEUER. Let me interrupt one moment to say I am going to go out of order and not have any further discussion of the relative merits of Wisconsin cheese and New York cheese until the panel gets some samples of both.

Mr. HUGHES. Getting back to acid rain, half of my life I spent as a college vice president. The other half I spent in industry. I would like to bring to your attention some facts that have not surfaced so far.

I don't particularly think of myself as an industrial representative, but there is no one else here to do it today, as I understand it.

Just within the last couple of months, in fact in May of this year, there were two very interesting papers published, which broaden our perspective considerably on the source of the sulfur.

Today, we have only heard about sulfur coming out of stacks from oils and coal or in the refining process such as the refining of nickel, but it appears there are other very important sources of sulfur in the atmosphere, possibly even more important. If anyone is interested, I will be glad to give references.

A group of scientists at Bell Telephone Laboratories—this is one of the great research laboratories in the world—has focused attention on carbonyl sulfide as a major agent of atmospheric sulfur corrosion. This gas is generated by microbiological activity, volcanos, forest fires and a variety of industrial processes, although natural sources appear to dominate. In rural areas such as the Adirondacks the carbonyl sulfide concentration is typically 4 to 11 times greater than the concentration of sulfur dioxide. Once again, we note that reducing industrial sulfur emissions will have little effect on the predominantly carbonyl sulfide concentrations in the Adirondacks.

In the same month, but in a different journal, there was reference to another component in the atmosphere. According to Robert Dukes, of the University of Rhode Island, some evidence suggests that biological processes in the ocean produce reduced sulfur compound such as dimethyl sulfide. Now, we haven't heard anything today about dimethyl sulfide. This compound can oxidize to form sulfuric acid. If so, we must learn how to distinguish between natural and man-made acid rain.

Now, industry is spending a large amount of money trying to do its share of the job—not only finding out whether there is a connection or what the connection is between that and ultimate precipitation, but also what they can do to remove sulfur from their emissions.

I will just name some of these without going into detail.

Something called flue gas sulfurization, where you get the sulfur out after it has been produced. There is something else called fluidized bed combustion, where you burn coal on a bed of lime, or some other material which will combine with the sulfide right in the fire, and so the stuff never gets to the flue.

Solvent refining, or washing of coal, has already been mentioned. There are improved burners which will reduce the amount of nitric oxide which is formed. And then, of course, there has been a lot of attention to lime and stocking lakes.

I would like to mention all of these processes cost a lot of money, and there hasn't been any attention paid, or not enough attention paid, to the cost of doing what we are asked to do. The best available technology has been mentioned today.

Let me give you some figures. At the present time, a plant, whether it is coal or nuclear, can be built at a cost of in the neighborhood of $1.5 billion. That figure has gone up dramatically in the last few years. Of that, today, 40 percent goes for environmental concerns. In another few years, when more strict rgulations are on the books, 60 percent of the cost will go to that, and by that time a plant may cost $2 billion.

Now, 60 percent of $2 billion is $1.2 billion. Now, not all of that is for acid rain, but a substantial part of it is for acid rain. So we are talking about something on the order of $300 million to reduce sulfurization per plant. One plant, $300 million.

Now, is it cost-effective to say we do that, or would it be better to spend $1 million a year liming and stocking the lakes in the Adirondacks until we find out what is the cheapest way of achieving the goal?

I have spent many years in industry, and I have lived through any number of crises, and any number of them—I can remember dashing in for a quick fix and spending money like it was water and only 2 or 3 months later we found out we didn't know what was going on and wasted our money.

I know this annoys people to say you are going to research the thing to death, but I don't have that attitude because I have earned my living in industry for 18 years, and I am well aware of the fact that you can't afford in industry to spend time researching something.

I think we have to pay attention to a wider variety of problems in connection with acid rain than have been voiced today.

I have here a list of research projects relating to acid deposition currently underway by industry. The total is some $26 million. So industry is not sitting on its hands and doing nothing, and I think we ought to give due thought to the fact, as you have said, Congressman, that the taxpayer is going to pay for this one way or the other. I think we do have to look at what is called cost-effective ways of achieving the goals. We can all agree that plants do emit sulfur; there is no question about that. There is a phenomenon called acid rain, but what to do about it is not all that obvious.

[The prepared statement of Mr. Hughes follows:]

Statement of Dr. Harold Hughes, Vice President
Adirondack Association, Inc.

September 18, 1981

A conventional summary of acid precipitation in the adirondack pictures coal burning plants in the ohio and nickle smelers in Sudbury, Ontario, emitting large quantities of sulfur dioxide into the atmosphere.

As this gas travels in a generally easternly direction it reacts with air and water to form sulfuric acids and other acidic sulfur compounds which are deposited on lakes to kill fish. In this conventional picture the conclusion is then reached that if legislation should forbid sulfur emissions our lakes would swarm with fish.

There are numerous difficulty with this over-simplified scenario. For example, according to a study conducted by Rennsselaer Polytechnic Institute, much of the acid in lakes accumulates in the snow cover during the winter and appears in short spurts during spring runoffs. But the Adirondack region of New York State has a unique problem. In most other parts of the world sulfate storage is greater than nitrate in the snowpack. In the Adirondacks this is reversed. The nitrate storage is generally much greater than sulfates.

During the winter months it is not uncommon to have "Nitric Acid Storms" where the nitrate to sulfate ratio is greater than 10. Thus, reducing sulfur emissions will have little effects on these spring nitric acid infusions into Adirondack lakes.

Another study just reported in May by scientists of Bell Telephone Laboratories focused attention on carbonyl sulfide as a major agent of atmospheric sulfur corrosion. This gas is generated by microbiological activity, volcanos, forest firest and a variety of industrial processes, although natural sources appear to dominate. In rural areas such as the Adirondacks the carbonyl sulfide concentration is typically 4 to 11 times greater than the concentration of sulfur dioxide. Once again we note that reducing industrial sulfur emissions will have little effect on the predominantly carbonyl sulfide concentrations in the Adirondacks.

From the 1850s to the 1920s the great irons mills to the west of us used soft coal, had no scrubbers and were much more fuel-intensive than modern plants. What about the water gas plants that lighted and heated a great part of the country to our west. How about the coal burning furnaces in homes? Were not all of these uses of high sulfur fuels making acid rain in those days? Why weren't there acid rain problems then?

Aren't all of the forest lands at high altitudes predominantly of the conifer family that are highly acid producing? It seems that a strong case can be made that we have no more acid now than years ago, but we do not have acid neutralizing events such as forest fires as we used to have.

A few years ago we were frightened about mercury in our fish, but later found out that even ancient specimens contained about the same amount. One of the most polluted air basins in the world is the Amazon River area with practically no people or industry.

Private industry is spending several millions of dollars per year not only studying these technical facts, but experimenting with new ways to reduce acid emission such as by fluid-bed desulfurization and new burners to reduce the production of nitrogen oxides.

To pass legislation now based on questionable data and incompletely piloted plant processes would cost many billions of dollars and probably not achieve the desired objectives. I can sympathize with those who impatiently oppose what they call "researching the problem to death." But we must realize that until we have firm technical answers to the problem and answers how to solve it, passing premature legislation will only be counter productive. Society has other more pressing needs for these billions.

Mr. Martin. Are there questions?

Mr. Hughes. I would like to make one additional comment which I forgot, and that is the easy way to solve this problem is to go nuclear. There was concern expressed earlier about nuclear waste. I would like to say something about that, because it seems to be the basis of a lot of hysteria.

Nuclear waste is of two sources: one from hospitals and the other from the weapons program. You will notice I haven't mentioned a commercial powerplant, because there is no liquid waste from the commercial powerplant. It does not exist. What comes out of a powerplant are spent fuel rods, and a fuel rod is about the size of the stand which is holding the American flag over there. It is an overly long fishing rod. It is solid when it goes in; there is no liquid. It is solid when it comes out. There is no liquid. It is easy to store. It has a lot of good uses in that form. It can't leach into the ground waters. It is perfectly safe.

There is no industry in America that has the safety record of the nuclear industry. The commercial industry I am talking about, it is now about 22 years old. There has never been a person killed; there has never been a person injured in the nuclear commercial industry. What industry has that record?

Three Mile Island, what happened there? Nothing happened. Nobody was hurt. It might be recalled the way the press built it up with a great circulation drive in 1978. That is exactly what happened.

Mr. Martin. Doctor, I just want to point out that I think we are going to be charged with being off the subject. I spend a lot of time on the subject you bring up as a member of the Interior Committee, and hearing you speak, I expect to see Mo Udall come in and call us to order.

We appreciate your testimony and later we will do more about nuclear waste.

I want to introduce Clarence Petty, of Canton, N.Y. Clarence is a forester by profession and a life-long resident of the Adirondacks. He is familiar with the potential economic impact of acid rain.

Mr. Petty?

Mr. Petty. Thank you very much.

I will not go over the items that I mentioned in my written statement since you probably already have those. I would like to point out, though, that in spite of what my friend, Harold Hughes, has said, the real problem comes from man-made SO_2 problems. It doesn't come from nature. I have been looking at these mountains for 76 years, and it is really sad to see what is happening to them as a result of this air pollution which we are getting.

I might mention that back in 1920, when we dug a 700-foot ditch and put a pipeline from the spring to our house that we put a piece of copper screen at the entrance of the pipe, and it took 38 years for that copper to disintegrate.

We changed it from the same roll of copper, put another piece on in 1958, and that only lasted about 11 years. It was again changed because it was deteriorating, and that lasted 7 years.

In 1976, I had to replace it again, and last year I had to replace it again. In other words, it has gone from 58 years down to 4 years, using the same identical copper screen. So you can see what has happened to our environment as a result of air pollution.

Now, if you look at the high altitudes around here, and you look at the spruce trees, as I have over these years, you will notice a very distinct change in the condition of the red spruce. They are dying. Many of them are dying. Some are actually deteriorating in vigor, and as we all know, any kind of a disturbance to the root system, whether it be acid or some other form, will naturally affect the vigor of the tree.

Now, it may be finally killed as a result of other insect and disease problems, but the lack of vigor is what really kills the tree. We are finding the same thing here in the Adirondacks as they found in Vermont and up in Canada and practically everywhere else. The acid rain is indeed affecting our forest growth. I hate to think what is going to happen to the forest industry 20, 30, 40 years from now if this continues.

This acid precipitation business is very much like cancer in the human body. It may be 20 years before the final impact of it really makes itself felt, but I am sure that you people are interested in solving the problem.

I don't think it is necessary to go over all of the details of what has happened to our wildlife. You can put on a pair of snowshoes and go up into these areas around the ponds where fish have been completely eliminated. You won't see a track of a single wildlife species that lives off of fish, because there is no fish there. This is having a great impact on many things. The economy of this area is being gradually strangled as a result of acid rain.

If you project your thinking into the future, in spite of what you have heard this morning from scientists, I believe that this area is in very serious trouble unless something is done to curb the air pollution over the Adirondacks.

Now, one of the things that I think is one of the worst things the Congress ever did was to allow these high stacks to be provided. Back in 1929, I drove through Canada by Sudbury, which has one of the notorious 1,300-foot smokestacks, and for 35 miles downwind from that plant there wasn't a single green piece of material anywhere. It was gone.

After they put the stack up there last year, I was by there, and they have green lawns, there are green trees growing around the base of it, but areas further north, to the northwest and Canada, are suffering from the effects of it. So all they did was remove the effects of the emissions around the plant and distribute it to their neighbors downwind.

I believe the areas to the west of us and southwest of us are doing the same things to the Adirondacks.

Mr. MARTIN. You meant 1,300 feet; Sudbury?

Mr. PETTY. That is right.

Mr. MARTIN. Thirteen thousand would be a real flight hazard.

Mr. PETTY. It is noticeable what happens when you put a high stack up like that. It just distributes it to your neighbors downwind.

As to the nuclear base, I don't want to get into that, because I disagree with my friend, Harold. I think it is the most expensive and the most health-destroying thing that could possibly happen. You are jumping from the frying pan into the fire if you go to nuclear from coal.

We do know there are methods of reducing SO_2 emissions from coal plants. We know it runs from 80 to 90 percent effective. Why not use it?

I would urge you, as members who really have the responsibility for making this very important decision, to take whatever initiative there is at the present time and try to reduce these emissions.

Now, in spite of what we hear from the scientists, that we don't know exactly all the things there are about it, we could say the same thing about cancer. We don't know all the things about it. But we do know enough about it so we can take some measures which have been effective. Why not do it with SO_2 emissions?

I think you people certainly could do something about it, and now. I don't think we need to wait. We need research, but we should not use that to put off action which could be taken now to reduce acid precipitation in the Adirondacks.

[The prepared statement of Mr. Petty follows:]

STATEMENT ON ACID PRECIPITATION IN THE ADIRONDACKS
COMMITTEE ON SCIENCE AND TECHNOLOGY - U.S. HOUSE OF REPRESENTATIVES
Presented by Clarence Petty at Lake Placid, N.Y. September 18, 1981

The detrimental effects of increasing acid precipitation on the Adirondack Park resulting from air pollution is alarming. Like cancer in the human body, the full adverse impact may not be apparent until too late for corrective action.

More than 200 bodies of water in the higher elevations are devoid of fish and hundreds of other lakes and ponds in the region have severely reduced fish populations. These were the waters that supplied trout fishermen with some of the best brook trout fishing in the state. Since brook trout fishing in the Adirondacks was one of the chief attractions for visitors to the area during the spring and summer season the economic loss is estimated to be in excess of a million dollars per year.

Accompanying the loss of fish in the waters is the noticeable decline in wildlife populations that are dependent upon fish for their food supply such as otter, mink, and osprey. Many visitors come to the Adirondacks to see, photograph or take various wildlife species and any reduction in numbers has a definite influence on the economics of the region.

Of vital concern to the health of both residents and visitors, is the disolved metals in drinking water eminating from copper pipes and the soldered pipe joints through which the acid laden waters flow. Lead and copper are cumulative in the human body.

A copper screen placed at the intake end of a 700 foot pipeline coming from our spring and leading to the house was put in place during 1920 and was replaced during 1958 when it started to disintegrate. The replacement screen showed signs of disintegration during 1969 and was again replaced. That replacement lasted until 1976 when it was found to be almost totally disintegrated. In 1980, after only four years, the screen had to be replaced again.

It is significant to note that each of the screens were cut from the same roll of copper screen purchased in 1920 so there is no difference in composition of the metal. The difference in screen life obviously comes from the rapidly increasing acidity of the water. Thousands of homes and business places are faced with not only added expense of repairs or replacement but more ominously with adverse health effects whose total costs are incalculable.

Many red spruce trees, particularly at the higher elevations are either dead, dying or showing evidence of decline in vigor which parallels the increasing acidity of adjacent waters. Certain nutrients required by trees are dependent upon bacterial action in the soil. When this action is retarded or destroyed by excessive acid conditions, the effects are reflected in reduced tree growth and vigor.

Forest industries in the Adirondacks have a substantial influence on the local economy so any deterioration of forest stands is certain to have an adverse economic impact.

STATEMENT ON ACID PRECIPITATION IN THE ADIRONDACKS
(continued)

Tourism is New York State's second most important industry and the Adirondacks have been a magnet for tourists. It is the aesthetic values of mountain scenery, ponds, lakes, rivers and forest; the fish, wildlife, clean air and high quality water that brings the visitors and upon which the major economic viability of the entire region depends. And it is these vital attributes that are being seriously eroded by the air pollution and its accompanying acid precipitation.

One does not have to be a scientist to recognize that air pollution is causing widespread damage in the Adirondacks and is accelerating at an alarming rate.

The cost of installing scrubbers in old coal burning plants would be substantial but far less than the cost of long term and in some cases, irrevocable damage now taking place downwind from these plants that are not equipped to minimize toxic emissions.

The excessively high smoke stacks built at coal burning plants to eliminate local air pollution, transfers the toxic fumes from its sources to distant areas downwind and constitutes a gross injustice to an area such as the Adirondacks where little or no air pollution origionates. Certainly no smoke stacks should be allowed that exceed the minimum height required to overcome downwash.

More research is needed relative to the acid precipitation problem but this should not be used as an excuse to delay action on initiating well known methods of reducing the emissions of sulfur and nitrogen oxides at their source.

Further economic and environmental losses are certain to increase and accelerate unless the Clean Air Act is greatly strengthened and the regulations properly enforced.

Mr. MARTIN. Thank you very much, Mr. Petty.

Are there questions?

I would like to take the opportunity, if I may just to make a couple comments and express my appreciation to these Congressmen who have come here, because of their very legitimate concern with the problem of acid rain. I can understand what it means when you have a schedule back in your district—and half a million constituents looking for your time and your interests—for you to be up here for a couple of days. Believe me, it is a sacrifice that these Members of Congress have made in the interests of good government.

There are a lot of people out there who like to criticize politicians in general, and Congressmen in particular, and that is all well and good; but I want to express my thanks to these gentlemen and to a number of other Congressmen who wanted to come here, who have a very legitimate interest and concern in what is going on but were just unable to come because of schedules in their own districts.

I did want to make one comment concerning something that Mr. Petty said right toward the end about the legislation that is going to be required and his disagreement with what the scientists had to say.

I respect your right to disagree with them, and in many ways I disagree with them, but the point is that as a practical matter in this world, when you are dealing with any piece of legislation, it requires the consensus of two houses of government and generally the chief executive, whether it be the State or whether it be the Federal Government.

You argue strong sanctions that are going to be part of the laws that you would want to have changed, in the face of some of the arguments by some of those scientists. Their opinions, of course, are appreciated to a greater or lesser extent, depending on where you are coming from. But for the Congressmen who want to represent their districts as best they can, to foist upon their constituents an expense where it can't be shown scientifically that there is a cause-and-effect relationship and that the legislation is going to be cost-effective—it makes it kind of difficult to get that legislation passed.

I don't want to understate or underestimate the importance of some of that scientific evidence that we heard today, as much as we might not like to hear it. It is difficult to discount whatever anybody else says, because we feel the impact here, and we know that most anything is going to be cost-effective that will ameliorate our situation.

Mr. PETTY. I agree with that. We don't want to act impetuously, but we do know of methods to reduce emissions. I think the real problem lies in reducing them, not in going to something like liming lakes, which is extremely expensive, and there are other side effects which have not even been mentioned today.

Mr. MARTIN. That is one reason why I wish Mr. Bowes could have been with us, and why I recommend we read his testimony submitted to us.

Mr. RUZOW. Congressman Martin, has there been any scientific testimony ever offered that the pollutants that go into the air, whether it be from auto emissions or from power plants, have benefited, are harmless?

Mr. MARTIN. I heard that during your original testimony. I hope the question you bring up is rhetorical. Otherwise, it would insult my intelligence.

Mr. RUZOW. It is rhetorical. I don't see the issue being whether or not you can make a direct causal connection between the emissions of a smokestack in Ohio and acid precipitation and adverse consequences in the Adirondacks. Rather, the question is, Isn't it true anything that goes into the air of the kind we just described is a detriment to clean air and to health?

Mr. MARTIN. I think it would be politically naive to suggest that the resolution of the problem is going to be to close down every plant and take the keys away from every car owner. We know that. What we are attempting to do is to get the best of all possible worlds in fairness to everyone in order to resolve the problems that we have.

Your point is well taken. I suppose that Adam and Eve, you know, in their first week on Earth, in all probability had an impact on the environment that was detrimental. Your point is very well taken, but the point is what we can do legislatively. We are going to do the best we can to ameliorate the situation. I think I speak for my colleagues.

Mr. RUZOW. It is very heartening to hear that.

Mr. MARTIN. At this point, we are past the time when we were originally going to close, but in deference to everyone here, we will give members an opportunity to make closing statements if they wish.

Congressman Scheuer, our chairman.

Mr. SCHEUER. I want to thank all my colleagues for coming here. I want to thank both of the panels this afternoon for their splendid testimony. I think the fact that I am here as an urban guy—I guess I am the only urban member here—plus the presence of the strong showing of the Republican members who represent mostly suburban and rural constituencies, indicates that Congress does operate across geographical lines and across party lines.

I am sure that I and other urban Congressmen will be supporting legislation designed to ameliorate acid rain which affects mostly the rural areas.

I am very proud to be a Member of Congress. I am very proud to be serving with the kind of men and women that you have seen today—the high excellence that they bring to this most extraordinarily complex and interrelated problem that is local, regional, national, that is global.

I think this has been a marvelous hearing, and I want to thank all my colleagues, and I want to thank the members of the panels this afternoon.

I want to particularly thank Dave Martin for the excellent and highly professional way in which he helped organize today's hearing and the splendid way in which he chaired this afternoon's session.

I am not one of those who hopes that the 98th Congress will find a Republican majority in the House of Representatives. I am very happy with the status quo in that connection. However, I do want to say if worst comes to the worst, and it happens, there will be a silver lining in that cloud because you are going to see a lot of talent emerging of the kind that Dave Martin has shown here today. He and my other colleagues will be chairing committees and subcommittees, and you will find there is plenty of excellence and plenty of expertise in that other party in our body. It is one of the things that makes me very proud to be a Member of Congress.

If such a thing happens, God forbid, Congressman Carney will be the subcommittee chairman, and I hope to be ranking minority member, and I hope he shows me the same loving care and compassion that I have shown him. I am sure he will.

I am sure we will have the same kind of constructive hearings.

Now, let's get rid of that nightmare and elect a Democratic Congress.

Bill, do you have anything you would like to add to that?

Mr. CARNEY. Yes, Mr. Chairman.

I would like to thank our host town, Lake Placid, and I would like to thank the people who had the patience to sit through this meeting. Indeed, it was a little chilly this morning, but it was a very constructive meeting.

I also would like to say our chairman, Mr. Scheuer, who, of course, comes from New York, is a champion of this problem of acid rain, and I think he is being very humble, because it is this Congress through the actions of this committee that we enhanced the amount of money being spent on acid rain, 75 percent more than what was originally submitted in the budget for fiscal year 1982.

I, therefore, think we can thank Mr. Scheuer, and he does show concern not only for urban problems but for problems throughout our country.

I know that will continue to be the pattern no matter who goes to the Congress of the United States.

One other significant thing we have to realize, that we have come to a place, and we have elevated the consciousness of the acid rain problem throughout the Nation because Lake Placid is a very famous place and a very highly exposed place, due to activities with the Olympics.

The Federal Government knows and understands Lake Placid, as do the Members of Congress. This has been very helpful, because we have elevated the awareness of this problem and hopefully we can start to find the solutions and work cooperatively with business, with environmentalists, with our fellow colleagues from each of the 50 States.

I think that will happen.

Again, thank you all for your hospitality.

Mr. MARTIN. We would like to take a few minutes for some of you folks who have been here throughout the day. We obviously have limited time, but are there those who want to ask questions or make comments? I wanted to thank the panel very kindly. If you have a comment, just come up and use the table here if there is something you want to say.

STATEMENT OF GERALD A. BARNHART, SUPERVISING AQUATIC BIOLOGIST, COLDWATER UNIT LEADER, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, BUREAU OF FISHERIES AND CONSERVATION

Mr. BARNHART. I would like to present a different side of the story that Dr. Singer talked about this morning, especially in regard to some of our larger lakes. Unfortunately, many people who are not on the scene have the idea that acid rain is only affecting some of our smaller bodies of water and the acreage affected is currently very small.

That is true, but there are several of our big famous, heavily-used lakes that are hovering on the brink. Some of these are very important not only in terms of the recreation they currently generate, but in terms of fish management statewide in the State of New York.

I would like to give you some examples of that.

Racquette Lake, which is one that Dr. Singer mentioned as not being threatened, I would beg to disagree with him on that. The State University of New York maintains a biological research station on Racquette Lake, and through continuous monitoring through the 1970's, they have documented a serious decline in pH in Racquette Lake.

The most recent data that our own organization has generated shows a pH of 5.88, which was 1978—5.88 puts it in the endangered classification.

Racquette Lake is probably our most serious concern among the big lakes because it is our big trout water, which means we use the native lake trout of Racquette Lake to produce eggs which we then transfer to hatcheries and raise and stock out into other Adirondack waters. If we lose Racquette Lake and lose that brood stock, there is going to be a very serious impact on our ability to produce lake trout fishing in the entire Adirondack region.

A couple of other examples: Cranberry Lake, in the western Adirondacks, 1979, a pH of 5.56. Cranberry is over 6,000 acres, by no means a small water. We have documented their failure of natural production of small mouth bass. Some of our colleagues in Canada, have identified small mouth bass as being very sensitive to acidification. They have reduced their ability to produce at a pH much below six. Currently, in Cranberry Lake, if you catch a bass, it will be a nice one because there are no little ones there.

Tupper Lake: The same thing almost happened to the wall-eyed pike in Tupper Lake. Tupper has the reputation for a low-density wall-eyed population, but some individuals of near-state-record-5, the pH in 1979 in Tupper got down to 5.76. I personally conducted a gill-netting exercise in Tupper in that year and documented the failure of several yearpacks of wall-eyed spawning. There were no juveniles spawning at that time. Fortunately, in the last couple of years, not fortunately from an Olympic perspective, but fortunately from a fish management perspective we had poor snow cover. Consequently, there wasn't quite as bad an acid flush in the spring, which is when wall-eyes spawn. Recently, the wall-eyes in Tupper have developed two successful year-cycles.

I just didn't want to leave you with the impression that we don't stand to lose some of our big waters. We do.

Dr. Singer's statement, in general, is correct. The bigger waters are better buffered and will last a long time, but there are several, some of them extremely important to the State management of fisheries, that are hovering on the brink. We can't wait for action on those waters.

Thank you.

Mr. MARTIN. Thank you very much, and well said. Your point is very well taken. I wish Dr. Singer were here. Thank you.

Is there anyone else?

STATEMENT OF MIKE RECHLIN, CANARI COORDINATOR, BOX 238, PAUL SMITHS, N.Y.

Mr. RECHLIN. My name is Mike Rechlin, I represent the maker of the buttons here, the Adirondack Coalition. Three things during the day I would like to make a comment on. One is that we heard scientist after scientist talk about more research money. I am in agreement with them. I am involved in research, myself. Research costs a lot of money; it is big business, and I have never in my career heard a scientist call for less research money. A point to make note of.

A second thing is, I was under the impression when I came here that we-all in the sciences and professionals were going to be educating you-all, and to a great degree, I think that might have been turned around.

One of the most illuminating things to me in recent times has been to hear Volker Mohnen's theory on transport and saturated air. One of the most interesting things I heard today was from Mr.

Carney, who made the comment, and it is a good comment to keep in mind, is, you hear about this theory. A saturated airshed means decreasing the amount of sulfates may not mean a raising of the pH of our rains here, but the problem is not lowered pH in the range. The problem is hydrogen irons which reach the ground and affect our watershed. Whether that comes in the form of rain or whether, as Mr. Carney so astutely pointed out, it comes in the form of dry fall-out which can be more linearly cut back doesn't make a lot of difference to the fish. It is the total that gets here.

A third comment I have is, while you read the total amount of information you have in front of you, given by the various speakers, I think it would be good, as you read Mr. Hughes' statement, to keep in another hand the statement prepared by Matty Pfeiffage which more or less refutes many of the points made in that statement. We don't get scientists to agree on many things, but a number of them in here at least agree on one thing—that that might not be right.

Mr. MARTIN. Thank you very much for your comments.

STATEMENT OF DAVID JORDAN, PROFESSOR OF CHEMISTRY, STATE UNIVERSITY OF NEW YORK, POTSDAM, N.Y.

Mr. JORDAN. You have mentioned that most of our discussion today has centered on the effects of acid precipitation on living systems, and that it is a rural problem rather than an urban problem to some extent. This is not exactly totally correct, because there are documented effects on urban structures. Decay of marble monuments, and corrosion is an important detriment which exists everywhere. Not just rural systems. This ought to be considered more widely, perhaps.

I would also like to bring up the suggestion of Dr. Mohnen about saturation. Saturated means the air will not hold any more sulfur dioxide. That is quite contrary to the normal definition of saturated. The air, in fact, could be totally sulfur dioxide, and there is no saturation concentration for sulfur dioxide. That is an unfortunate term that has been used in this case, I believe.

Mr. CARNEY. It was my understanding that what the good Doctor said that the ability for water in the clouds to extract sulfur dioxide and turn it into an acid is saturated. I understand we can all agree you can put a lot more pollutants into the air, and you are correct in that regard. He was talking about the ability of rain water to bring it down.

Mr. JORDAN. I intend to carry it just a little bit further.

His theory suggests there is only so much acid rain that the cloud system can make, and there ought to be some limit on how much acid could come in the rain in the wet fall, ignoring the dry fall that has been brought up.

The most acid rain that has fallen has a pH of 1.5, which is different from 4.17 that Dr. Mohnen suggested would be the Adirondack average. This pH of 1.5 is roughly 800 times as much acidity as is falling at present on the Adirondacks. Obviously, if we reach this maximum wet-fall concentration, we still have some way to go.

One last point is a question rather than a comment. Is anybody aware of the cost of building a 1,300-foot stack without pollution and maintaining it, as compared to building a 100-foot stack with controls? Perhaps it might even be a cost-benefit factor to build this sort of stack with proposals as opposed to building and maintaining a tremendously tall structure.

Mr. MARTIN. Mr. Sensenbrenner?

Mr. SENSENBRENNER. I thank you very much.

Mr. MARTIN. Is there anyone else?

If not, I thank you very much. The hearing is adjourned.

[Whereupon, at 4:30 p.m., the hearing adjourned, to reconvene at 9 a.m., Saturday, September 19, 1981.]

ACID RAIN

SATURDAY, SEPTEMBER 19, 1981

House of Representatives,
Committee on Science and Technology,
Subcommittee on Natural Resources,
Agriculture Research and Environment,
Lake Placid, N.Y.

The subcommittee met, pursuant to adjournment, at 9:10 a.m., in the Whiteface Room, Olympic Center, Lake Placid, N.Y., Hon. James H. Scheuer (chairman of the subcommittee) presiding.

Mr. **Scheuer**. Good morning, and welcome. This is the second day of hearings by the Science and Technology Subcommittee on Natural Resources, Agricultural Research and Environment.

This meeting came about when I attended a joint parliamentary meeting in Canada a few months back with Ian Watson and a number of his Parliamentary colleagues.

We met for several days with Members of the U.S. House of Representatives and Senate. In the course of discussing the problem with Ian and others, we explained the jurisdiction of our committee, and we made informal plans to have another hearing subsequent to that somewhere near the border to carry on this discourse between Canadian and American parliamentarians on this very vexing and complicated and frustrating problem of acid rain.

Our subcommittee has major jurisdiction in the field of acid rain because we have jurisdiction over all of the research and development program of the National Oceanic and Atmospheric Administration [NOAA]; over the research and development programs of the Environmental Protection Administration [EPA]; and over the energy research and development programs of the Department of Energy.

Our committee impinges on acid rain from the perspectives of all of the Federal agencies that have a slice of the pie. Also, I might say that I personally am the ranking majority member of the Health and Environment Subcommittee that will be considering the Clean Air Act. So I get it in both of my committee assignments.

Of course, we selected this Adirondack area because it is a counterpart to the portion of Canada just above the American border that is a victim of acid rain, and 50 percent of their pollution problem comes from the United States.

This area is suffering a comparably devastating effect from acid rain. Approximately 25 percent of the acid rain precipitation here emanates from Canada, so there is a joint aid program with each country contributing some of its poisonous effluents to the other in a hands-across-the-border gesture.

Approximately 200 of these lakes are eutrophic and do not support fish life. Approximately 10 percent of all of the Adirondack lakes are desperately threatened, with another 9 or 10 percent of them threatened for the future. In terms of the impact of acid rain on this community, on the Adirondack community, I guess the threat to their fish life, their forest growth and crops, is more or less comparable to the order of magnitude of the threat in Canada.

Of course, while it only affects a comparatively small population group, in terms of the urgency of the danger, the psychological and the economic cost, it is very comparable in its devastation of the morale and of the psyche of the people in this community. So we are very concerned about acid rain.

The program this morning will be that a number of Canadian experts will discuss this issue and give us the results of recent Canadian research.

Then I suppose we will hear from the distinguished Canadian members, and then after that, I suppose the Americans will contribute.

I hope we will have an easy-going and free-flowing exchange.

I would like to turn now to my colleague, Dave Martin, our host Congressman, who represents this area and lives with the problem of acid rain throughout the year. To him, the problems of acid rain and the anguish of acid rain are a daily reality.

Mr. MARTIN. Thank you very much for your kind remarks, and particularly to my Canadian friends and colleagues I extend a warm and hearty welcome. I look forward to these proceedings.

For us this is the second day of hearings; having had a full day yesterday concerning the subject.

As has been pointed out, this is my home district, and for your continued information, it is the biggest district east of the Mississippi River.

I would suggest it probably has as much if not more common boundary with our good friends and neighbors in Canada to the North as any Member of the House of Representatives. We appreciate not only the cordial relationships we have had throughout our history, but we also appreciate your continued travel to places like Lake Placid, N.Y., and your constituents and friends and neighbors, and we like to be good hosts because we are in the tourism business.

I am about as subtle as a train wreck on that subject. Keep coming. We like to have you.

The problem of acid rain obviously is very important to Canada, but I did want to point out it is in a sense no more important to Canada than it is to me, on account of Don Mitchell and myself, and a few other Congressmen here in the Northeast who suffer the same kinds of problems as do our Canadian neighbors. We look forward to hearing the results of the research that has been done by the Canadian Government, and we look forward to a free flow of communication.

I offer you a warm welcome, and thank you so much for coming.

Mr. SCHEUER. Thank you, Dave.

And now for the ranking Republican member of our committee, who has cooperated to the last degree in all of our efforts and is an active and contributing member of the subcommittee.

Congressman Carney, of New York.

Mr. **Carney.** Mr. Chairman, I think what Dave Martin said was appropriate, welcoming our Canadian counterparts and their team of experts. Certainly we all extend that same welcome to you. We look forward to a spirit of cooperation to try to resolve a problem that is recognized by both nations. I think the sooner we get to listening to the expert witnesses, the better off we will be.

Mr. **Scheuer.** Thank you, Mr. Carney.

Without further ado, I will introduce the Honorable John Fraser, Progressive Conservative Member from British Columbia, and formerly Minister of Environment of the Canadian Government. We are very much looking forward to what you have to say, John, and you can introduce your colleagues for us and carry on.

STATEMENT OF HON. JOHN FRASER, PROGRESSIVE CONSERVATIVE, BRITISH COLUMBIA, CANADA

Mr. **Fraser.** Thank you very much, Mr. Chairman. I speak for my colleagues here and our colleagues who have come here to address you both from the Federal Government and from the government of the Province of Ontario.

I want to assure you all that we appreciate a very great deal the hospitality and good will that you have shown us, not just on this occasion, but on many other occasions in which we have had the opportunity to visit with our American colleagues.

The particular reason for being here is, it is serious. The purpose of our visit is to persuade you that we have a very serious problem with acid rain and that you have it, too. It is to persuade you that we cannot resolve our problem in Canada without help from your country, but you can't resolve your problem in the parts of the United States that are receiving acidification without help from us. We do not intend to argue the old saw about who is doing what to whom and by how much.

The fact of the matter is that you cannot clean up your act down here without our help, and the same applies to us.

Mr. Chairman, you will be hearing technical information from our officials, and you will be hearing from myself and both of my colleagues at the close of the information from our officials, but I want to, both for your information, Mr. Chairman, and for the information of the ladies and gentlemen who are here, I want to introduce both of my colleagues.

First is our most senior colleague, Mr. Ian Watson, who is sitting to my left, who is a Member of Parliament from the riding, or what you would call the district, of Chateauguay, the Province of Quebec. He was first elected to the House of Commons in 1963, and has maintained, lo these many years, the confidence of his electors and I can affirm that he has made a very effective and significant contribution to debates and work in the Federal House of Commons in Canada.

He is presently the House of Commons Cochairman of the Canadian-United States Inter-Parliamentary Group. He is also chairman of the House of Commons Standing Committee on National Resources, and he is, in addition, a general rapporteur of the scientific and technical community of the North Atlantic Assembly. He is a member of the Government Party and he is a liberal, and despite the fact that we are in different parties, I want to tell you that Ian and I have been, for a long time, very close personal friends.

My colleague on the right—probably should be sitting on my left, but nonetheless—is Mr. Derek Blackburn. Derek is a Member of Parliament from the constituency of Brant, in Ontario, and was first elected in 1971 in a Province which has overwhelmingly, for lo these many decades, voted conservative provincially, but nonetheless Mr. Blackburn has been able to persuade them he is at least conservative enough to be sent to the House of Commons from an Ontario riding.

Derek has been for a number of years now the environment critic in the House of Commons for the new Democratic Party, and he has been my colleague during this past year on the House of Commons special subcommittee studying acid rain, and that subcommittee will be delivering a report later on next month and Derek will be speaking about it in a few minutes.

Mr. Chairman, fellow colleagues of the House of Representatives, and ladies and gentlemen, we want to assure you that we are very pleased to be here, and we appreciate the kindness that you have extended to us in inviting us.

We hope when we leave, after what we have had to say, which I hope will be accurate, but nonetheless probably blunt, we will leave on good terms, and that that invitation to come back to New York will still be standing, if I can put it that way.

Mr. SCHEUER. New York and Washington.

Very good.

Mr. FRASER. I think what I should do now is introduce to you Mr. George Rejhon. Mr. Rejhon is the counsellor on environmental matters in the Canadian Embassy in Washington. He is in charge of our team, and I would ask you, George, if you would introduce the members and then take over.

Mr. REJHON. Mr. Chairman, I want, first of all, to thank you and your colleagues for having invited us and making it possible for us to speak to you today. We will give you a technical briefing based on the Canadian perspective of what we know; in other words, what are the scientific and technical underpinning of our concerns with regard to long-range pollutant transport.

In my introduction of the following technical discussions I want to indicate briefly how we perceive the problem in Canada, what bilateral machinery has been set up to deal with it, and what we think we need now to do as two nations in cooperation to meet existing commitments and begin to deal with the problem.

First, I would like to introduce my colleagues and give you an idea of what they will be saying. First of all, to give you an oversight of the scientific knowledge that we have and what we think it means, we have with us Jim Bruce. Jim is assistant deputy minister of what we call the Atmospheric Environment Service of the Federal Environment Department. That makes him roughly assistant secretary of what would be the atmospheric half of NOAA under your governmental system. He also is in charge of the Federal acid rain research effort.

Jim has a master of science degree in meteorology from the University of Toronto. He has previously directed the Canada Center for Inland Waters, our principal water research institute, and just before assuming his duties in charge of Atmospheric Environment Service, he was assistant deputy minister of an office called the Environment Management Service, also of the Federal Environment Department, which made him roughly the equivalent of a hypothetical assistant secretary in charge of fish and wildlife, forests and the Bureau of Land Management.

On my left is Tom Bridges. Tom is with the Ontario Provincial Ministry of Environment. He has a Ph. D. in chemistry from the University of Western Ontario. He supervises the hematology unit of that ministry and has specialized in investigating the effects of acid rain for about the past 5 years. He also serves as Canadian cochairman of the Aquatic Effects Group under the Memorandum of Intent.

Dr. Van Volkenburgh is also with the Provincial Ministry of Environment. He directs their air research branch. Gregg holds a doctor's degree from New York University in atmospheric physics and chemistry. He has done a variety of upper atmospheric research. Some of this has been done in association with NASA and NOAA. He has also done some research in the private sector and currently also serves as vice chairman of the work group 2 under the memorandum of intent.

Alex Manson, to my right, has a master of engineering degree from the University of Western Ontario, and is now chief project coordinator of the Air Pollution Control Directorate of the Federal Environment Department. He has been there for the past 10 years and has done a variety of work in the area of pollution control and setting ambient standards in Canada. He is now a member of both work groups 3-A and 3-B.

Finally, although he is not a member of this panel, we have with us Dr. Peter Sommers, who is scientific coordinator of the Federal Acid Rain Research program. Peter holds a doctor's degree in meteorology, and he has done a variety of things. I would mention two: He has been a visiting scientist with NCAR in Boulder, Colo., and recently spent a couple of years with the World Meteorological Organization in Geneva.

Mr. Chairman, the problems associated with transboundary air pollution, including, of course, the long-range transport of acid precursor pollutants but also photochemical oxidants and toxic chemicals, clearly have now emerged as a major environmental concern to both our countries.

The most urgent concern for most of us is acid deposition, and we will be focusing largely on that. Acid deposition is known generally by the short-hand term acid rain.

I guess it has become clear by now, but I want to emphasize it, that it is the judgment not only of the present federal environment minister, the Honorable John Roberts, but also his predecessor, the Honorable John Fraser, and of many people in Canada, all of our Federal political parties, and government of the provinces, that acid rain is the most important environmental problem facing Canada today.

While it is not recognized, perhaps for a variety of good reasons, in the same way as a national problem in the United States, we are gratified that in parts of your country, particularly the Northern States and especially here in the Adirondacks, you share our concerns.

Before we move on to the technical presentations, I thought I should try to set the stage a little in terms of how we see the scientific information relating to the need for policy direction. We believe long-range pollution transport is not just an environmental problem; it is a socioeconomic problem, and it is a problem of a transboundary and interjurisdictional nature.

As such, we believe any attempts to analyze its significance, to determine what the science means and to devise remedies, must take into account the socioeconomic implications, particularly those inherent in the strategy of dealing with pollution, something which we do in both our countries, whereby we emit pollutants from tall stacks and allow air currents to export that pollution across provincial, State and international boundaries. In short, pollution export is cheaper than pollution control.

To the extent that the costs of doing business in one jurisdiction are thereby artificially depressed and then go on to generate costs in surrounding jurisdictions where the pollution descends, we believe long-range air pollution transport could be called a kind of negative interstate commerce. This is because it does, in fact, amount to the transport, in economic terms, of goods across boundaries; only the goods are of a negative nature.

In our view, there is no doubt that the scientific understanding of the acid rain phenomenon, at this time, both justifies and necessitates the beginning of ameliorative action.

As you will see, we believe that our knowledge of the complex relationships between source emissions and eventual downwind impacts is surely imperfect. You will see that important pieces of the puzzle remain blurred, and that obviously more research is needed.

As I hope will also become evident from the presentations that follow, the general outlines of the picture are clear. If we are to protect the already seriously stressed acid sensitive ecosystems that currently are threatened in much of Eastern North America, and the tourist and recreational industries which depend on a healthy environment, if we are to reduce present levels of damage to manmade structures, and if we are to avoid possible long-term health effects, we must begin now in both our countries to devise ways of reducing the emissions of the oxides of sulfur and of nitrogen.

Canada and the United States have a long record of working well together to manage the transboundary environment in the interests of both our people. Landmark principles in the relationship include, first, the 1909 Boundary Waters Treaty. It provides, among other things, that neither country shall pollute water crossing the boundary to the injury of health or property of the citizens of the other country.

We also have the 1935 trail smelter arbitration, that smelter being in British Columbia. This stipulates that no State has the right to use its territory in such a manner as to cause injury by fumes to the territory of another State. We both subscribe to principle 21 of the Stockholm declaration which states that nations have the responsibility to assure activities within their jurisdictions do not cause damage to the environment of other nations. Beyond that, we have a long record of mutual commitment and cooperative practice developed over many years by which we have learned to deal with environmental problems that inevitably crop up quite regularly along various parts of our common border.

Against this background, and in recognition of the continental nature of the problem that both countries contribute to and both countries suffer from, Congress, in 1978, directed the Department of State to negotiate the Transboundary Air Quality Treaty with Canada.

The essential foundations of the bilateral negotiating process which has just begun, were laid in the 1980 Memorandum of Intent, where, among other things, both countries committed themselves to negotiate an agreement which was intended to deal specifically, though not exclusively, with acid rain.

To support the negotiating process established under the Memorandum of Intent, or MOI, we established four technical work groups of United States and Canadian experts, and their general mandate was to produce an agreed scientific base and some conclusions from that science, and to identify appropriate and effective technical control strategies that might be used in both our countries under a bilateral agreement.

The first set of reports was produced on schedule early this year. The second set has been somewhat delayed, but I am told they are soon to be on their way.

As envisioned by the MOI, negotiations were to begin once the second set of reports became available. Nevertheless, an initial negotiating session was held last June, the target date also set in the MOI.

It is also important to note that the MOI committed both of our countries to another set of actions. In addition to moving down the track of bilateral negotiations, and in recognition of the fact that this would take some time, to MOI calls for interim actions available under existing authority to begin the task of reducing transboundary air pollution. In fulfillment of this commitment, Canadian Federal and Ontario governments have taken a number of actions. Ontario, for example, has moved to require substantial emission reductions over a period of some years from two of Canada's major sources of air pollution, the famous smelter in Sudbury and Ontario Hydro's thermal plants.

The Federal Government amended the Clean Air Act following a unanimous vote in both Houses of Parliament to provide clear and enhanced authority for the Federal Government to control transboundary air pollution. Having done that, we in Canada obviously look forward to seeing the United States taking similar interim measures that would be modest in cost and scope, as are ours, but of great significance in demonstrating in a tangible way that both of our countries have set a course in the direction of major emission reductions.

We are encouraged, for example, by indications that the State of Ohio may be moving toward coal washing. This is the kind of modest initial step that we believe starts us in the right direction.

Obviously, measures such as that and the measures we have begun to take in Canada cannot be seen as being able to deal with the problem, but at least they do start us in a direction of reducing the emissions.

Having said that, though, I have to add that we continue to be dismayed by the continuing record of very serious noncompliance by some major polluters and as well as by their attempts to obtain exemptions and relaxations of existing legal standards.

Finally, we are worried about some recent indications that there are those who would like to weaken your Clean Air Act in the course of the present debate on that very important piece of legislation.

The reason for that worry is that we believe that no bilateral agreement, even when it is in place, can, of itself, control transboundary air pollution. For a bilateral treaty to be effective, each country has got to have strong and effective Federal legislative and administrative machinery that would give meaning and substance to any bilateral accord. For this reason, we believe that we have a direct stake in your current Clean Air Act debate, and we trust that you won't take offense if we offer our comments in the course of a political debate that we feel is potentially of great significance to our country.

We believe what your amended act does or does not do, especially in the context of long-range pollutant transport, will have a great impact on Canada.

It is our hope that the technical presentations that we make today and your subsequent discussions with Canadian Members of Parliament, will provide you with useful technical information as that debate unfolds.

[The prepared statement of Mr. Rejhon follows:]

PREPARED STATEMENT OF GEORGE REJHON

INTRODUCTION

I should like first of all to thank you Mr. Chairman, on behalf of the Government of Canada for your invitation to meet with you and present this technical briefing. Our presentation is intended to give you a better understanding of the Canadian perspective on the scientific and technical underpinnings of our concerns about long range transboundary pollutant transport. In introducing the discussion I will indicate how we perceive the problem, what bilateral machinery has been set up to deal with it, and what more needs to be done, if both countries are to meet existing commitments.

The problem associated with transboundary air pollution, including the long range transport of acid precursor pollutants, photo-chemical oxidants, and toxic chemicals, have now emerged as major environmental concerns. However, the issue of most immediate and urgent concern is acidic deposition - generally known by the short hand term, acid rain. In the judgement not only of Canada's present Minister of the Environment, the Honourable John Roberts, but also of his predecessor, the Honourable John Fraser--whom we are honoured to have with us today--acid rain is the most important environmental problem facing Canada. It is recognized as a problem of similar dimension, if not nationally in the United States, then certainly in the North Eastern States, and particularly here in the Adirondacks.

Long range pollutant transport is an essentially transboundary and inter-jurisdictional problem. As such, attempts to analyze its significance and devise remedies must take into account the socioeconomic implications inherent in a strategy of dealing with pollution by emitting it from tall stacks and allowing air currents to export it across provincial, state and international boundaries. In brief, pollution export is cheaper than pollution control. To the extent that costs of doing business in one jurisdiction are artificially depressed in this way, and then generate socioeconomic costs in jurisdictions where the pollution descends, long range pollution transport might be called negative interstate commerce.

In our view there is no doubt that the scientific understanding of the acid rain phenomenon both justifies and necessitates the beginning of ameliorative action. Our knowledge of the complex relationships between source emissions, and eventual downwind impacts, is surely imperfect. Some important pieces of the puzzle remain blurred, and more research is vitally needed. But as will be evident from the presentations which follow, the general outlines of the picture are clear. If we are to protect the already seriously stressed acid-sensitive ecosystems currently threatened in much of eastern North America (and the tourist, recreational, and forestry industries which depend on a healthy environment), if we are to reduce present levels of damage to man-made structures, if we are to avoid possible long term human health impacts, we must begin now in both countries to devise ways of reducing the emissions of oxides of sulphur and nitrogen.

Canada and the United States have a long record of working cooperatively to manage the transboundary environment in the interests of both our peoples. Landmark principles in the bilateral environmental relationship include the 1909 Boundary Waters Treaty, which provides that neither country shall pollute water crossing the boundary to the injury of health or property in the other country, and the 1935 Trail Smelter Arbitration, which stipulated that no state has the right to use its territory in such a manner as to cause injury by fumes to the territory of another state. We both subscribe to Principle 21 of the Stockholm Declaration, which asserts that states have the "responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states".

Against this background, and in recognition of the continental nature of the problem both countries contribute to and suffer from, Congress in 1978 directed the Department of State to negotiate a transboundary air quality agreement with Canada. The foundations of the bilateral negotiating process were laid by the 1980 Memorandum of Intent, wherein both countries formally committed themselves to negotiate such an agreement, intended to deal specifically, although not exclusively, with acid rain. To support the negotiating process the Memorandum of Intent, or MOI, established four Working Groups of U.S. and Canadian experts to produce an agreed scientific data base, and to identify appropriate and effective technical control strategies. The first set of reports was produced on schedule; the second set has been somewhat delayed. As envisioned by the MOI, negotiations were to begin once the second set of reports became available. Nevertheless, an initial negotiating session was held in June, the target date set in the MOI.

It is important to stress that the MOI also committed each country to take interim actions available under existing legal authority to begin the task of reducing transboundary air pollution pending conclusion of the formal bilateral agreement. In fulfillment of this commitment Canadian federal and Ontario governments have taken a number of actions: Ontario has moved to require substantial emission reductions over a period of years from two of Canada's significant sources of air pollution, INCO's Sudbury smelter, and Ontario Hydro's thermal power plants. The federal government, for its part, amended the Canadian Clean Air Act following a unanimous vote in both Houses of Parliament last December, to provide a clear and enhanced authority for the federal government to control transboundary air pollution.

We in Canada look forward to seeing the United States taking similar interim measures; measures that would be modest in cost and scope but of great significance in demonstrating in a tangible way that both our countries have set a course in the direction of major emission reductions. We are encouraged for example, by indications that the State of Ohio may be moving toward coal washing. This is the kind of modest initial step that starts us in the right direction although such measures alone cannot resolve the problem. But we are dismayed by a continuing record of serious non-compliance by some major polluters, as well as by their attempts to obtain exemptions and relaxations of existing standards.

Mr. **Rejohn**. Thank you, Mr. Chairman.

Now, I would like to ask Mr. Bruce to continue our presentation.

STATEMENT OF J. P. BRUCE, ASSISTANT DEPUTY MINISTER, ATMOSPHERIC ENVIRONMENT SERVICE, ENVIRONMENT CANADA

Mr. **Bruce**. I think we are all aware that the atmosphere does not pay any attention to manmade boundaries. Warm spells that we get in this part of the world and in Eastern Canada come from maritime tropical air masses that move up from the Gulf of Mexico and across Central States into the Northeastern part of the United States and Southeastern Canada. Cold spells you get mostly come from the Northwest, passing over Central Ontario and Quebec enroute to Eastern U.S.A.

Now, when these air masses, as they move, become laden with manmade contaminants, of course the transboundary movement of airborne pollutants occurs.

There are several manifestations of this general phenomenon, the most notable being acid rain, but of major importance as well is the transport of ozone and its chemical precursors, and the long distance movement of toxic chemicals—metals like lead, cadmium and organics like PCB's.

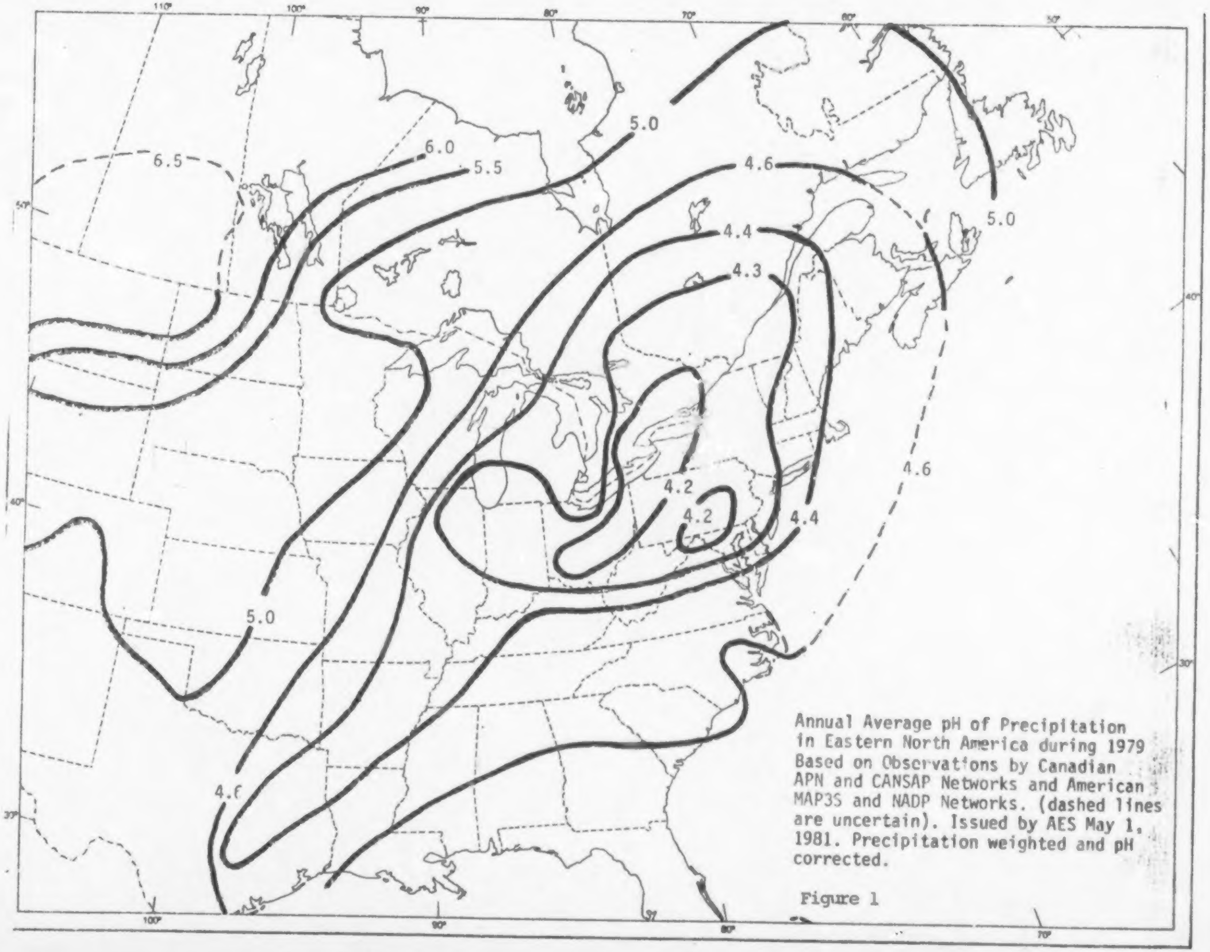
As far as acid deposition is concerned, I suspect many people are somewhat confused about the scientific facts of the case. Some claim the world is coming to an end in a few weeks, and, on the other hand, there are those who claim there is no proven damage, and we don't know the causes, so we can't take any action.

Let me try in a very general way—and this will be backed up in more detail by my colleagues—to clarify what we do know about acid precipitation. I will also note some of the things we don't know but wish we did.

We now have at least a decade of modern research on acid rain to draw upon, from Scandinavia, from the United States, and from Canada, with an especially intensive effort in the past 3 years in North America.

This summary of what we now know is based in part on the scientific consensus emerging from the work under the memorandum of intent that our two countries are contributing to so actively.

There are seven points that I want to make.
Could I have figure 1, Peter?


110°
100°
90°
80°
70°
60°
50°
50°
40°
30°
6.5
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4.4
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4.2
4.2
4.4
4.6
5.0
5.0
4.6
100°
90°
80°
70°

Annual Average pH of Precipitation in Eastern North America during 1979 Based on Observations by Canadian APN and CANSAP Networks and American MAP3S and NADP Networks. (dashed lines are uncertain). Issued by AES May 1, 1981. Precipitation weighted and pH corrected.

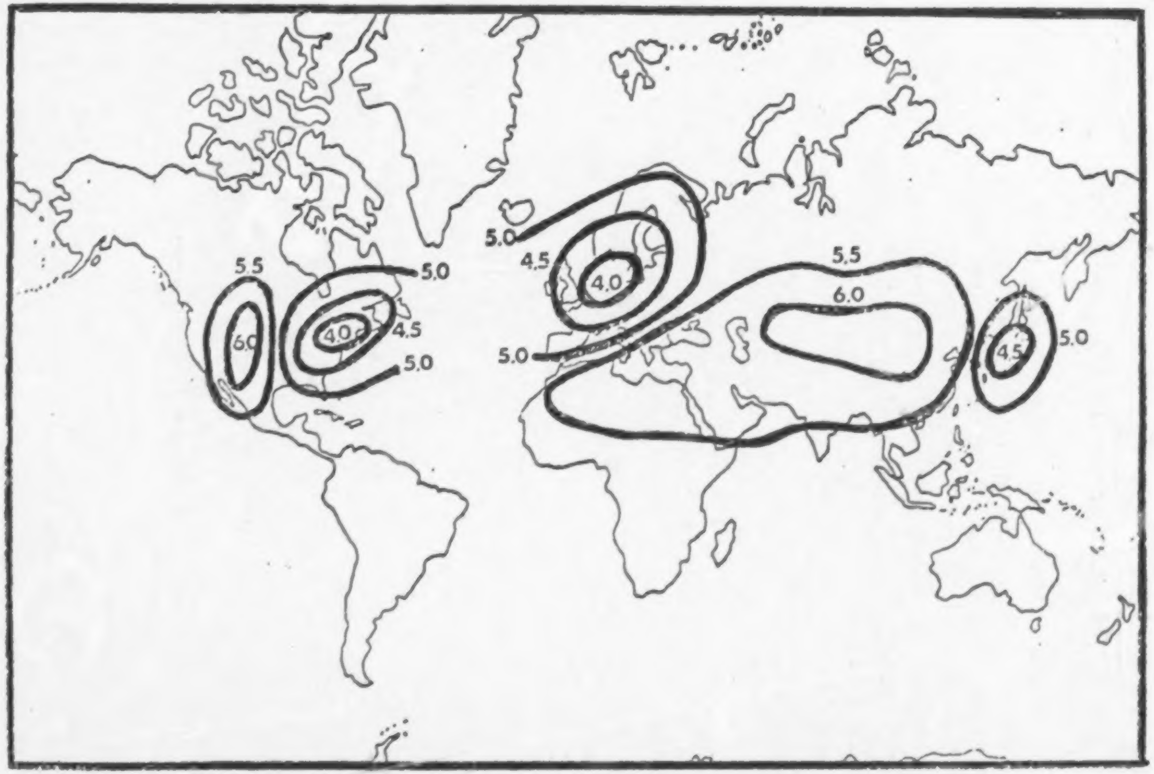
Figure 1

Precipitation over Eastern North-America is becoming very acidic. This is the most recent map of data, based on observations in the United States and Canada, of the annual average precipitation, pH, or acidity.

Now, 5.6, which is way over in here, represents clean rain. The 4.6 line encloses the area which is at least 10 times more acidic than clean rain. The 4.6 line goes away around here and covers all the inhabited parts of Eastern North America, except Florida.

The area which is about 40 times more acidic than natural rain is this area in southern Ontario, New York State, the Adirondacks, parts of Ohio, parts of Pennsylvania.

Figure 2, please.


5.5
6.0
4.0
4.5
5.0
5.0
5.0
4.5
4.0
5.0
5.5
6.0
4.5
5.0

Adapted by Whelpdale from
Gravenhorst et al (1980)

Figure 2

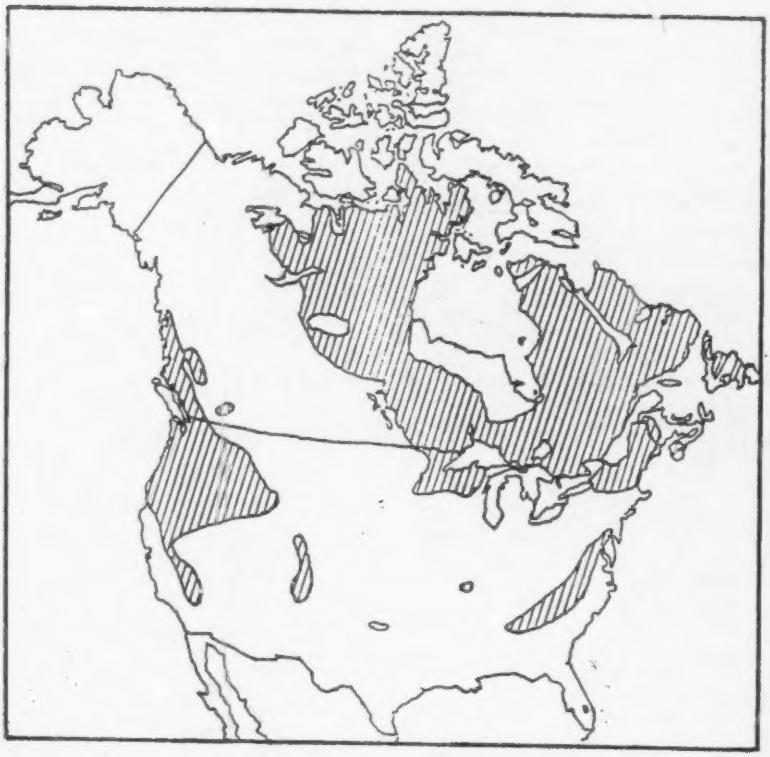
This phenomenon is not a worldwide phenomenon, but it is a phenomenon that occurs in several other parts of the world. This is a map of the world which shows where the low pH precipitation occurs. I think you may have heard some irrelevant stories about low pH rain in Greenland and Mauna Loa, but there are only two places in the world where average pH in rain is in the range of around 4, or 4.2, and that is in Eastern North America, associated with the heavy industrial development there, and in Northern Europe, associated with the heavy industrial developments there.

That is the first thing that we know. We know that the rain is very acidic in the areas that we are concerned about—Southeastern Canada and Northeastern United States.

Because we can analyze the precipitation and find out what causes the acidity, we know that it is caused by sulfur compounds and nitrogen compounds; nitrous oxides, initially, and sulfur dioxide, initially, which get converted in the air in the long-range transport process into acids. The further they move, the more sulfur dioxide and nitrous oxides become converted into acid. These compounds are the ones largely responsible for the high acidity, low pH values we see on this map. (Fig. 5 follows.)

Figure 5

North American Areas Containing Lakes That Are Sensitive to Acidification by Acid Precipitation



Source: James N. Galloway and Ellis B. Cowling, "The Effects of Precipitation on Aquatic and Terrestrial Ecosystems — A Proposed Precipitation Chemistry Network," Journal of the Air Pollution Control Association 28, no. 3 (March 1978): 229-235, figure 5.

We don't have a really serious acid rain problem unless this acidic precipitation falls on areas that are highly sensitive to that acid. Unless, in other words, it falls on areas where there isn't much basic or alkaline material to neutralize the acid falling from the skies. But there are, unfortunately, very large areas of our country and yours in which there is very little basic or alkaline material in the lakes, in the rivers, and in the soil. This is a map of Eastern Canada. This is Ontario, here, and this is the New York State border here. The areas in red are areas of very high sensitivity, where there is very little buffering capacity and the acid falling from the sky will very quickly change both soils and lakes and rivers to more acid conditions.

The yellow areas are moderate sensivity and the green areas are low sensitivity.

There are certain areas I would like you to note particularly. This area in Ontario, about which you will hear more, this huge area in Quebec, and this region of Nova Scotia.

A map of the United States shows a number of important sensitive areas, particularly in the Adirondacks and the Northeastern part of the United States and some up around the Boundary Waters Canoe area and in northern Michigan. (See fig. 5.)

What happens when there is very little buffering capacity in the lake is that it rather quickly becomes acidic under the onslaught of acid rain, and when lakes become acidic, no fish or other creatures upon which they depend can be sustained. You will remember that big area of rainfall pH which was 4.6 or lower. But if the lakes have a pH less than 4.7, they will become devoid of fish. You find no fish there. The ones with pH higher than that still have some fish around.

Now, in Eastern North America, in Ontario, and in the Adirondacks there are literally, now, hundreds of lakes that are dead.

Perhaps even more serious than that, is that there are hundreds of thousands of lakes that are dying. These are lakes which have low concentrations of basic or alkaline substances, very little buffering capacity, and are subject to very heavy acid loading.

Their conversion to acid lakes and the death of their unique ecosystems are simply a matter of time. Acid loadings of these lakes are steadily eroding the residual alkalinity or buffering capacity, and this is very widespread.

For example, in the Province of Quebec, in that big red area, 46 percent of the lakes sampled in that area north of the St. Lawrence River were showing signs of loss of alkalinity or had become acidic. I should mention that in the Province of Quebec there are, altogether, something like 1.1 million lakes, of which about half are in the area seriously affected by acid rain.

In a real sense the problem is not so much the hundreds of dead lakes that we now have, but the enormous number of dying lakes in both countries, and they are dying quickly.

Mr. **Scheuer**. What is the realistic time frame we have to work with?

Mr. **Bruce**. Some lakes, it is a year. For other lakes, if they still have quite a bit of buffering capacity, it could be a decade. It is just a gradual loss of the buffering capacity of those lakes that we will be seeing.

One of the serious problems in lakes which are still retaining some buffering capacity, even though it is eroding away, is that we get acid shock conditions in the spring. Highly acid melt water from the northeastern winter snow pack has been observed to produce acid shock because all of the acid comes out very quickly in the spring melt, and this can kill adult fish and has been shown to do so on many occasions.

Finally, let me mention these rivers in Nova Scotia. (Fig. 3–45 follows.)

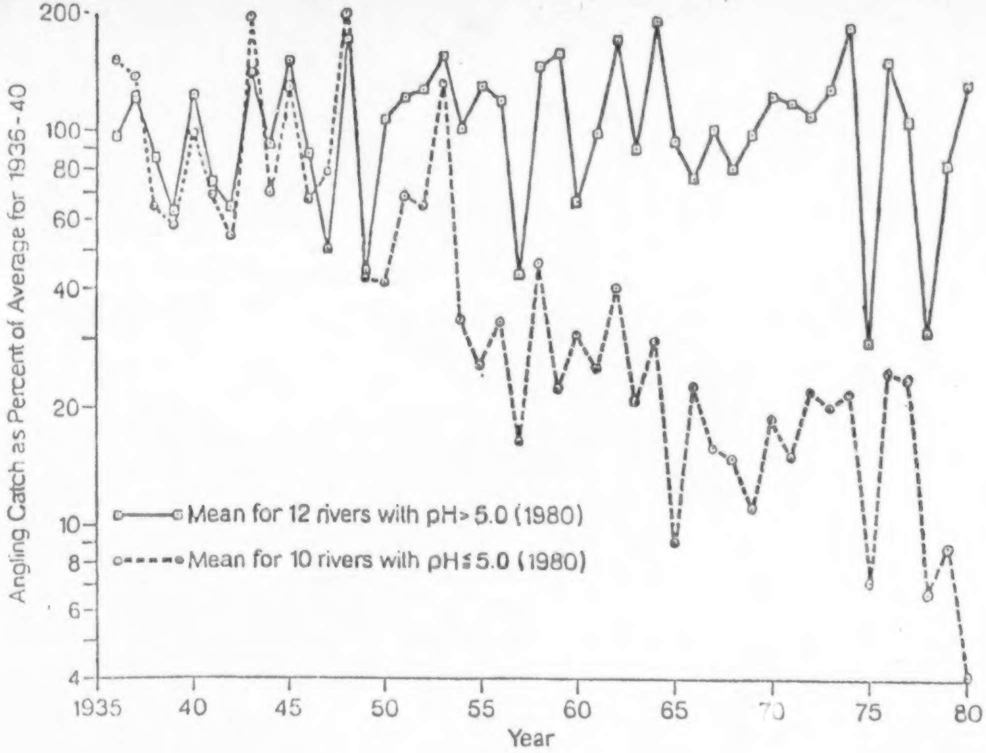


Figure 3-45. Average angling success for Atlantic Salmon in 22 Nova Scotia rivers since 1936. The data were collected from reports of federal fishery offices (from W. Watt, unpublished manuscript 1981).

There are nine rivers in Nova Scotia which were formerly salmon-spawning rivers where the pH of the river has declined over the past two decades. This is well documented. These rivers no longer have Atlantic salmon spawning. The slide shows you how unsuccessful fishermen now are in all the rivers with low pH and how successful they continue to be in all the river systems which have a lot of buffering capacity and been able to withstand, so far, the onslaught of the acid rain.

In short, there is strong scientific consensus on, first of all, the highly acidic nature of the precipitation in Eastern North America due to sulfur and nitrogen emissions, and, second, there is general agreement about the damages to lakes and rivers and the continuing stress on these systems.

When one considers that anglers spent an estimated $800 million in Canada in 1975 on sports fishing, and when you realize that summer cottaging by a lake is a way of life for millions of urban Canadians, and, of course, many Americans, you can begin to understand the reason for the public uproar over acid rain.

I might also note—you mentioned the tourism concerns in the Adirondacks—in Canada, 1 million U.S. tourists visited Canada in 1975, and 2 out of 3 of them said they came for the fishing.

There is also a strong consensus about where these substances which cause the acid rain are emitted. (Fig. 2-2 shown. A copy follows.)

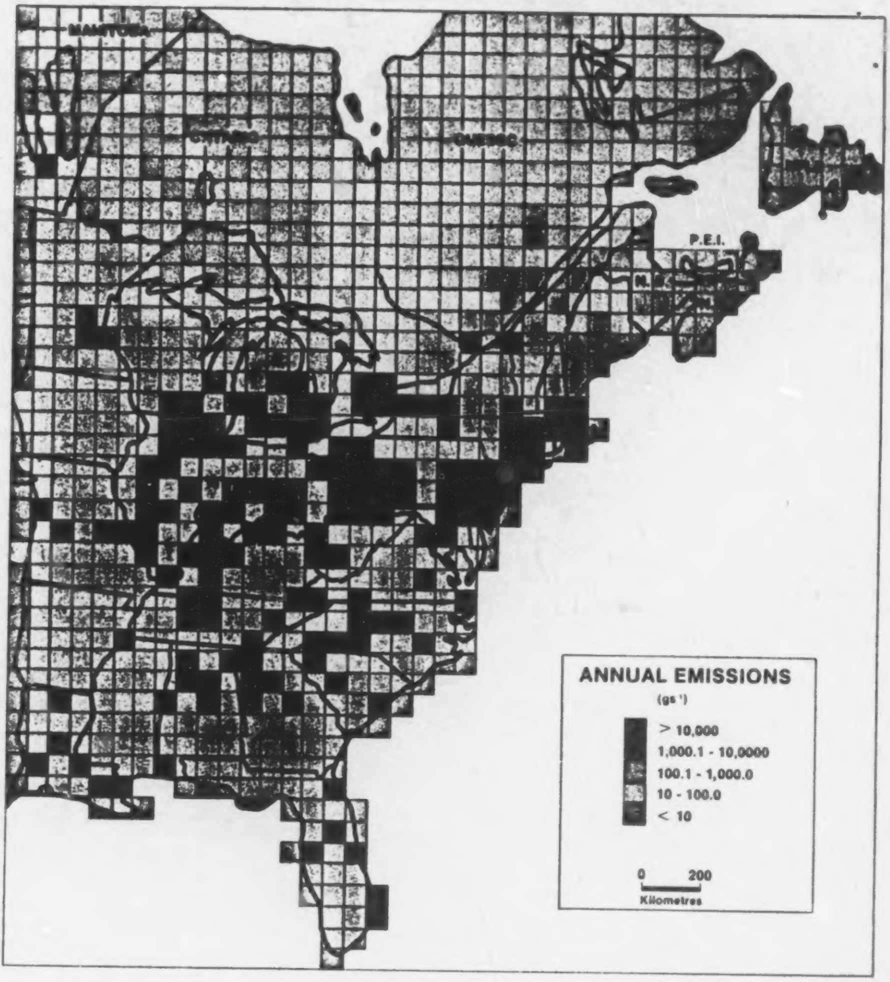
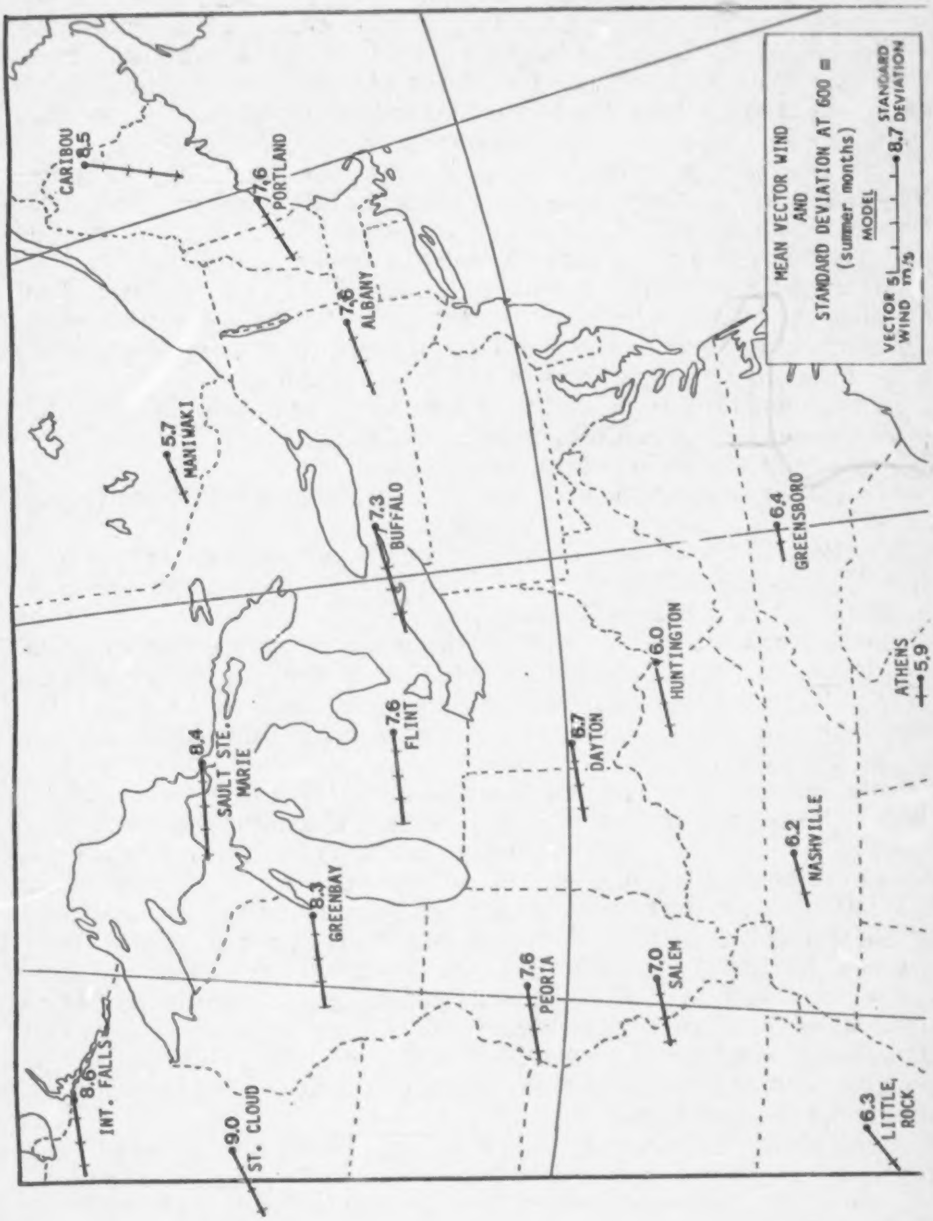

MANITOBA
ONTARIO
QUEBEC
P.E.I.
N.S.
ANNUAL EMISSIONS
(gs⁻¹)
> 10,000
1,000.1 - 10,0000
100.1 - 1,000.0
10 - 100.0
< 10
0
200
Kilometres

Fig 2-2: Magnitude and distribution of nitrogen oxides emissions in eastern North America (from RCG 1979)

This slide shows the emissions by geographical squares. The red squares are the ones that have lots of—you can't read the legend—but the red squares are the ones where emissions are very high and you can see that the area of the Ohio River Valley, the area of the Midwest, are areas of very large agglomerations of high emission of sulfur dioxide. I can also see a few blocks of high emissions in Canada, especially those associated with nonferrous smelters, which are the largest sources of SO_2 coming from Canada.

The other thing there is a lot of agreement on, and understanding of, is the general atmospheric transport patterns. (Slide shown. A copy follows.)


MEAN VECTOR WIND
AND
STANDARD DEVIATION AT 600 MB
(summer months)
MODEL
VECTOR WIND
5
m/s
8.7
STANDARD DEVIATION
CARIBOU
8.5
7.6
PORTLAND
7.6
ALBANY
5.7
MANIWAKI
7.3
BUFFALO
6.4
GREENSBORO
6.0
HUNTINGTON
5.9
ATHENS
8.4
SAULT STE. MARIE
7.6
FLINT
6.7
DAYTON
6.2
NASHVILLE
8.3
GREENBAY
7.6
PEORIA
7.0
SALEM
8.6
INT. FALLS
9.0
ST. CLOUD
6.3
LITTLE ROCK

This just is a simple way of illustrating by wind roses for the lower part of the atmosphere the average transport of emissions.

The longer the line, the more frequently does the wind blow from that direction. You can see for places like Ottawa, Buffalo, North Bay, and Detroit, that wind from the southwest and south are very common. This is, of course, a summer average condition.

This is a very simple depiction. We also use very complex mathematical models of atmospheric transport and chemical transportation to provide the linkage between the emissions in the last slide and the lakes and other ecosystems that are being affected.

All of these atmospheric tools and methods tell us that first of all at least as much acidity from U.S. sources as from domestic emissions are affecting Canada. That is, 50 percent or more of Canada's acid rain comes from sources in the United States.

In the sensitive areas of the Adirondacks and New England, 15 to 25 percent of the acidity comes from Canada.

Some people have said that we must wait——

Mr. **Martin**. Would you repeat that last statement about 15 percent?

Mr. **Bruce**. Depending on which technique you use, between 15 and 25 percent of the acid rain falling in the Adirondacks and New England is coming from Canada.

Some people have said that we must await completely verified, highly sensitive models before we can design control programs. This is like waiting to cure a cancer patient until we have the perfect cure rather than using existing knowledge and information to get on with the job.

It is estimated by United States-Canada Working Group No. 1 under the Memorandum of Intent that a maximum wet sulphate loading of less than 20 kilograms per hectare for each year is needed to protect the majority of surface waters.

What we know right now is that the loadings of the most seriously affected areas in New England, New York, Quebec, and Ontario are double this or more. That is, we are grossly overloading these areas with sulfate. So substantial reductions in sulfur emissions are needed in those regions which affect these sensitive areas. Our models are good enough to tell us which emission regions are important, and that is enough for an initial control program. Refinements can be made later.

Incidentally, this is very much the approach our two countries took in our generally successful joint United States-Canada effort to clean up the Great Lakes. The 1972 agreement addressed the gross pollution problems, and the agreement was designed to allow us to refine the effort as more research results came in and we knew more about it.

We have the knowledge to do this right now, for an air quality agreement between the two countries.

Now, what are those things we wish we knew more about? Two of the most important are the impact of acid rain on forests and the effects on human health. The forests are of tremendous economic importance to Canada. Eastern forests in the eastern part of the country alone yield some $4 billion per year in export earnings, and they provide a livelihood for almost 200,000 workers. In connection with forests I think the best thing I could do is to quote Prof. Ellis Cowling——

Mr. **Scheuer**. What percentage of your national workforce would that be?

Mr. **Bruce**. On a national scale, 10 percent of the workers in Canada are employed in the forest industry. The statement that I think best summarizes what we now know about the potential impact on forests has been made by Prof. Ellis Cowling of the School of Forest Resources, University of North Carolina. He says:

> Recent experiments in Germany have demonstrated significant correlation between amount of soluble aluminum in forest soils, death of the fine feeder roots in spruce, fir and beech forests, and widespread decline in the growth of these forests. Acid deposition and dry deposition of acid-yielding substances have been postulated as a probable cause of these coincident effects.

Some researchers think that these forest effects are already widespread in the Adirondacks. Others think there may be other unknown causes for the tree diebacks.

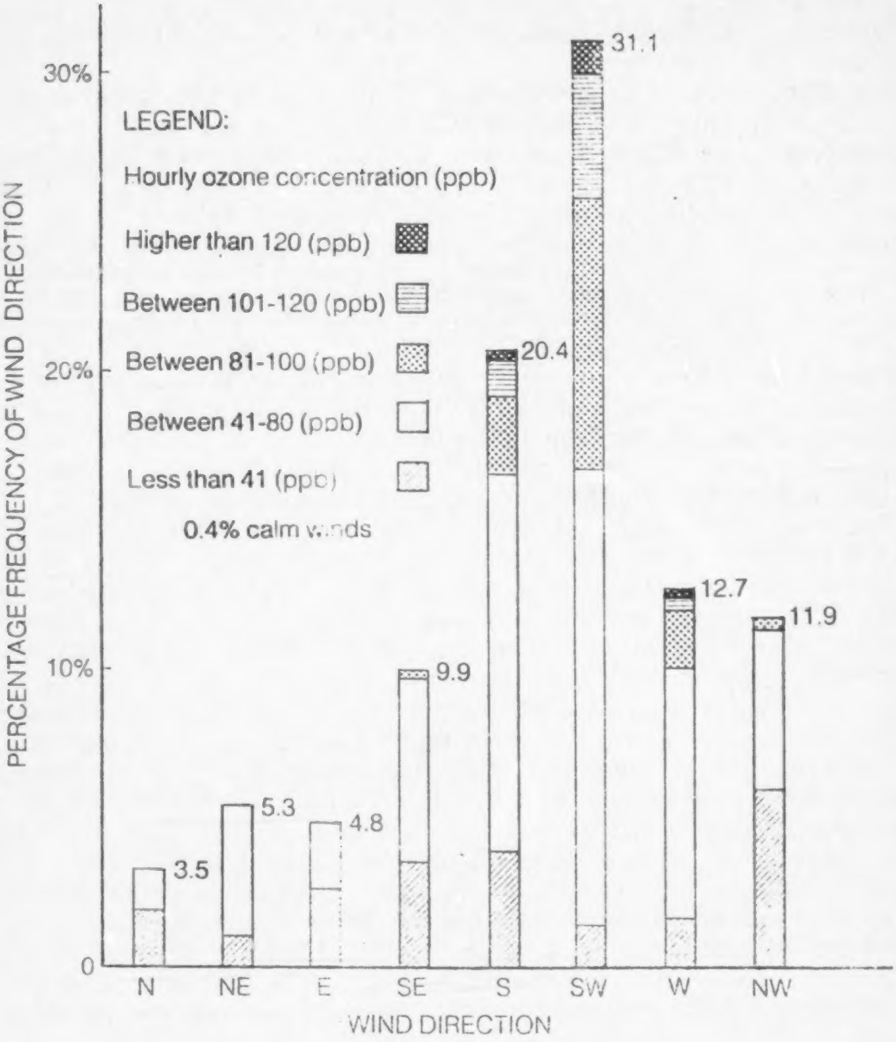
Research in North America must urgently address the extent to which these potentially devastating effects are occurring here.

The most worrisome potential health effect is that associated with increased leaching and mobility of trace metals from rocks, sediments, and pipes and their effects on drinking water supplies. It has been long known that a decrease in pH—increased acidity—of raw water supplies will cause greater corrosion of lead, copper, zinc, and cadmium from pipes and result in, at times, high concentrations of these toxic metals in tapwater. This is a particular hazard in small communities or cottages drawing water supplies directly from lakes or ground water. Some very disturbing data are beginning to come in from both Eastern United States and Canada. We need to know much more about this, and quickly, if the health of cottagers and residents of small communities are to be protected.

I have talked so far about acid deposition. But other airborne pollutants cross boundaries, too. Ozone has been of serious concern in southern Ontario since work in the 1960's showed that episodes of high ozone concentrations involving pollutants transported from Michigan and Ohio, caused extensive damage to bean and tobacco crops.

Ozone damage to tobacco leaves—this is a common sort of occurrence in the summer in southern Ontario.

Ozone concentrations also cause many other effects like the cracking and decay of rubber and plastics and could have serious health effects. (Fig. 13 shown. A copy follows.)



Frequency distribution of hourly wind direction at specified averages of hourly ozone concentrations (ppb) during peak ozone daylight hours (1300-1900 EDT) in July and August 1976 at [illegible].

Ozone concentrations occur over the 80-parts-per-billion standard—that 80-parts-per-billion standard is designed to protect human health and vegetation. You can see here 80 parts per billion—above 80 parts per billion are these speckled areas and darker areas, and these occur in southern Ontario when the wind is from the south and the southwest, being transported across the international border into southern Ontario. In fact, that is the only time in which such high ozone concentrations occur in this region.

The International Joint Commission has studied to some extent the long-range atmospheric transport of toxic chemicals into the Great Lakes systems. They have concluded that significant deposition of PCB's, of lead and likely of mercury on Canadian waters of the Great Lakes system can be attributed to U.S. sources and some of the fallout of such chemicals onto U.S. waters of the Great Lakes system comes from Canada.

It seems clear from scientific findings accumulating over the past decade that the air pollution problems of the 1980's will not be local problems. They will be primarily transboundary problems—interstate problems and interprovincial problems. International transport of contaminants have reached proportions where major damage is being done in downwind jurisdictions by upwind emitters. Given this increasing realization, governments must deal effectively and get their legislation in place to deal effectively with transboundary pollution. We are very much hopeful that this will be recognized by the United States in considering revisions to the Clean Air Act.

Let me just end by saying it is unthinkable to us that the political leaders, scientists, and citizens of the affected regions in either of our countries would permit the continued onslaught from the air on our most priceless assets, our water and our soils.

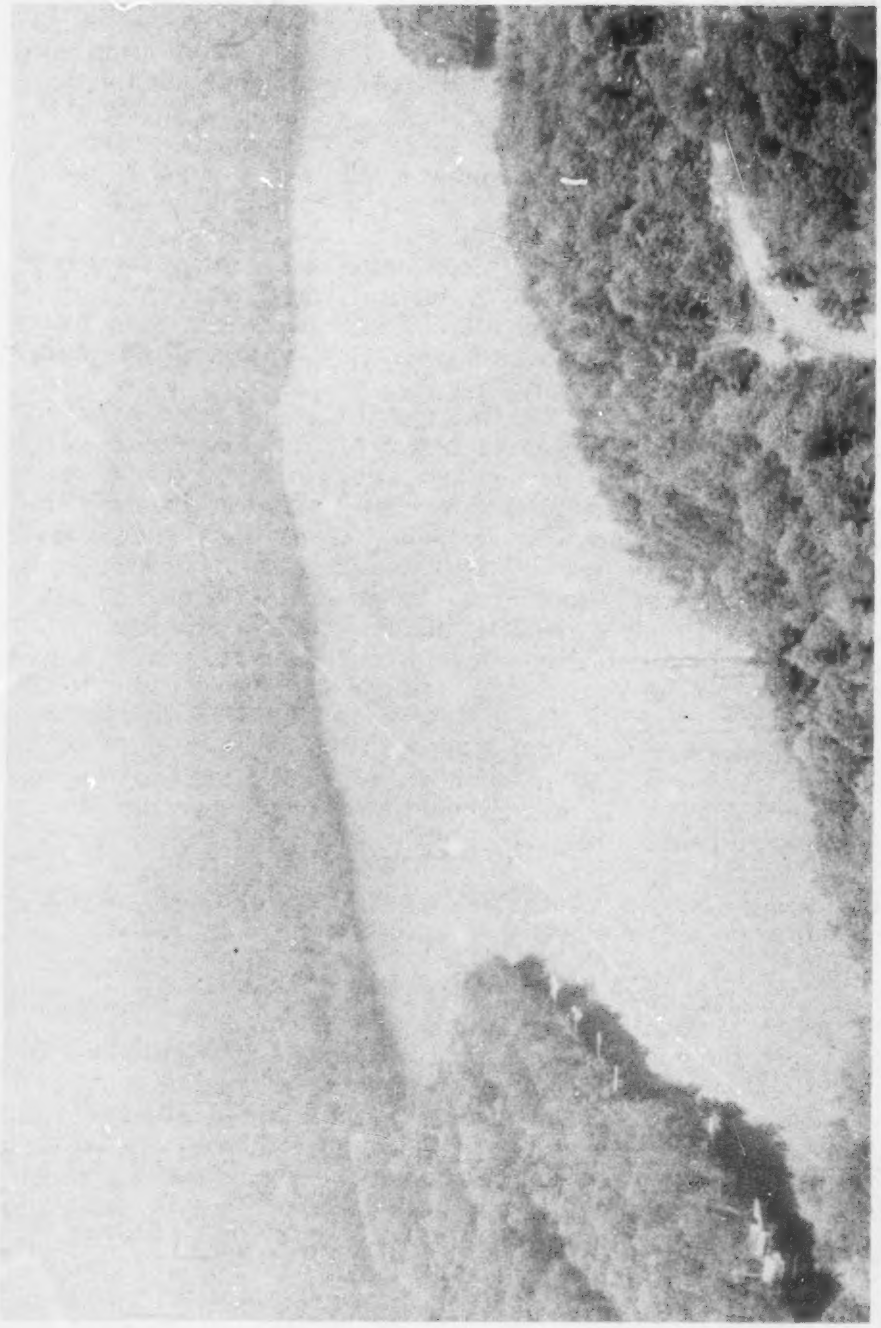
Thank you.

Mr. REJHON. Now, I would like to ask Tom Brydges to speak to you about some of the effects we have documented in Canada.

STATEMENT OF DR. TOM BRYDGES

Dr. BRYDGES. Thank you very much.

Mr. Bruce has outlined the general nature of the problem, and some of the effects we are having on surface waters. The purpose of my presentation is to provide some of the specific details and some of the research approaches that are leading to the conclusions that you have been given this morning. I am going to use a series of slides. I have corresponding photographs which I will supply to you. (Slide 1 shown. A copy follows:)



SLIDE 1

The first slide which I have shows one of the lakes we have that is a typical lake. These lakes cover areas of Ontario through Quebec, similar to the Adirondacks. These lakes are representative of an extremely unique ecosystem that is unique in the entire world. There are hundreds of species of fish, birds, and other life operating in a very complex ecosystem. Almost all of the species that exist in these areas interact at some point in their life cycle with the water, because the area is approximately 8 percent water, and clearly if you pull the rug out, or if you destroy the aquatic system, you pull the rug out from under that entire ecosystem, and you will end up with a complete collapse.

Dr. **Brydges**. The next slide, No. 2, shows one of the sample lake weirs we have set up. This represents what you might call a sort of a valve. It is a measuring device. We set these up in the streams that are going into the lakes and the streams coming out of the lakes. What you then do, the thing is calibrated so the amount of water coming in and coming out of the lake can be measured. The water is sampled frequently so that through time we are constructing what we call substance budgets, perhaps a term you are very familiar with in the United States these days, how budgets can go up and down.

What we are looking for is information to tell us what is happening in that lake, how fast is the water quality changing, to address the question raised about how much time have we got left.

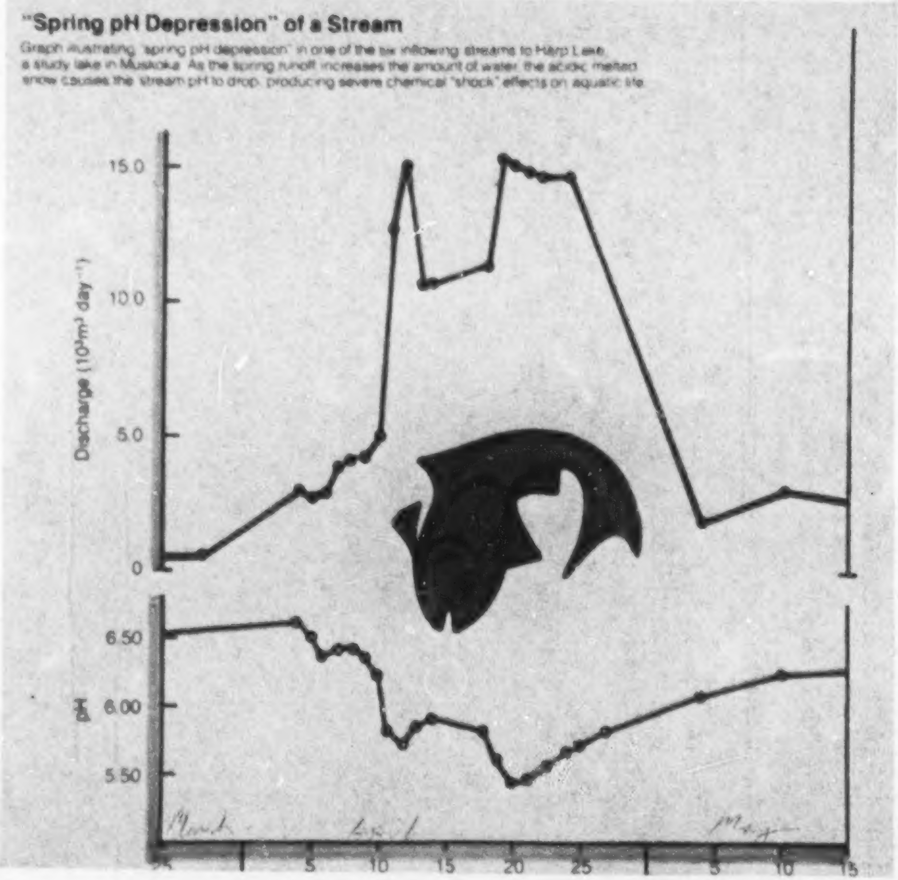
Another fundamental question is how much acid loading will these lakes stand, how much can they accept before there is damage, and what is the fate of the material. We are, of course, measuring the material going into the watershed from the rain, so we have a complete inventory of what is coming down, where it is going, and what the impact is that it is having on the surface water. (Slide 2 shown. A copy follows:)

SLIDE 2

The next slide, No. 3, will show one of the same types of structures in the wintertime.

The point of this is that the whole field program is a 12-month-of-the-year operation. We don't just go up when the weather is nice. At this point in time, when this picture was taken the roads to these areas are inaccessible by either snowmobiles, because the snow starts to get soft, or by 4-wheel-drive vehicles; so we switched to helicopters.

The point of this is that, the acid continues to come down all winter long, collects in the snow, as opposed to running off in the form of rain, and when spring finally comes, the combination of warm weather which, of course, melts the snow and more rain which in itself is acidic, combines to cause the famous spring pH depression. (Slide 4 shown. A copy follows:)



"Spring pH Depression" of a Stream

Graph illustrating "spring pH depression" in one of the six inflowing streams to Harp Lake, a study lake in Muskoka. As the spring runoff increases the amount of water, the acidic melted snow causes the stream pH to drop, producing severe chemical "shock" effects on aquatic life.

SLIDE 4

Now, this slide, No. 4, shows the flow of water as measured through one of those weirs that you saw in the previous slide, top line. The scale is lost. There is March, April and May. Clearly what is happening, we have the spring runoff, a large flow of water is coming through, a large amount of acid is coming through, and the pH of the water in the bottom graph declines, a very healthy value of about 6.5 in this particular stream in late winter down to a value below 5.5 which is certainly a stress condition, but perhaps not dangerous.

Mr. **Mitchell**. I don't understand the significance of the two curves. Could you go over those again?

Dr. **Brydges**. Here, the flow is being measured in early spring. There is some rain in here, and this is the amount of water as recorded through the weir. Of course, the flow increases from practically zero to fairly large amounts. There is tremendous variation. About 80 percent of everything that comes through the weir in terms of substances will come through in the spring runoff. The rain, the water, the nitrogen, the phosphorous, just about everything that comes through, comes through there, unfortunately, including the acid.

The pH, which is a measure of the acid content, shows here at a healthy value, and begins to decrease simultaneously with this larger increase in flow.

Mr. **Sensenbrenner**. Do you have a chart that shows the expense of liming on top of the ice? Would this prevent this pH depression in the spring?

Dr. **Brydges**. I don't have a chart to show that, but that is one of the things that has been done in Sweden. Indeed, they go around and spray limestone on the surface of the snow, and it can reduce the effect. That is the purpose of it.

One of the difficulties you have is that the flow is so large in the spring. The flow is so large that even the acid loading gets away from the limestone, and, in fact, you get spring pH depression still. That is a purpose of the liming that is being done. It is not perfect.

In one of the rivers in Sweden, where they put a lot of money in this, they had the fisheries going fairly well, but had severe spring shock this previous spring and for several days the pH went down. Of course, if a fish dies, he only dies once. If he dies in April, it is not much good to them to know, in this particular example, if he dies or suffers damage in April; it is not going to do much good to know things will be better next July.

During what is known as the big event recently at the end of August and September this year, we had 11 days of very heavy rain in this area—about 6 inches of rain, which represents about 10 percent of the annual loading of water. The pH of that rain indicated that the acid content was about double the long-term average so that 10 percent of rain brought in 20 percent of an annual leading of acid, and the weirs started to show the same condition. There was a runoff similar to the spring flow conditions and some of the pH's went down in the same way we have shown on this slide.

The full effect of it is not known. We have indicated before that the same phenomenon can happen in any time of the year with a very heavy rain, and so the biological organisms in these streams and surface waters of the lake can get a little hammer on the head at any time of the year, and they certainly got a dandy clout on the head in these lakes a couple of weeks ago.

Mr. **Mitchell**. Mr. Chairman, is it all right to ask questions now?

Mr. **Scheuer**. Yes.

Mr. **Mitchell**. How do we determine the pH of lakes? We have had studies in New York State in the Adirondacks, and I think they take one or two readings and determine the lake has a pH of so-and-so. I can see here how it varies and fluctuates. I don't know how you could possibly assign a pH without many different samplings during the year.

Dr. **Brydges**. You are absolutely right. If you go out and sample all the lakes, sample the pH in all the lakes in July, you won't see this at all. Historically, it is a matter of observation that some of the early measurements that were made in spring conditions for various people, for various reasons, were held in suspicion because we didn't believe things could be so low. We thought the pH meter must be wrong. Historically, we know that is the case: The pH was right. There is no question

That is why we have these so-called calibrated watersheds where we put a tremendous amount of effort. It is a very expensive, very intensive study that goes on in these lakes to get this kind of information, with continuous monitoring equipment installed as well.

Mr. **Mitchell**. You are not only looking for some kind of mean or average; you are looking for the lowest point.

How long does it take low pH's to wipe out the fish population?

Dr. **Brydges**. This chart, No. 5, shows how one lake looked during the runoff (Plastic Lake). When the pH went down, it reached conditions where we had observed kills to adult fish in this lake. The combination of low pH and high aluminum, which, in fact, comes off at this stage as well—a lot of the acid, when it goes into the watershed, dissolves the rock, even at this stage, not very much of that acid is getting through to the surface water. Even in the spring runoff the percentage of acid which gets through to the surface waters is still very small. Unfortunately, some of the acid that gets used up as it were, or neutralized, is not being neutralized by dissolving a nice innocuous material like limestone. It is dissolving the bedrock material which has a lot of aluminum. You have simultaneously high aluminum and low pH. That condition is lethal to adult fish.

The most important aspect of this is that this phenomenon is happening in thousands and thousands of lakes.

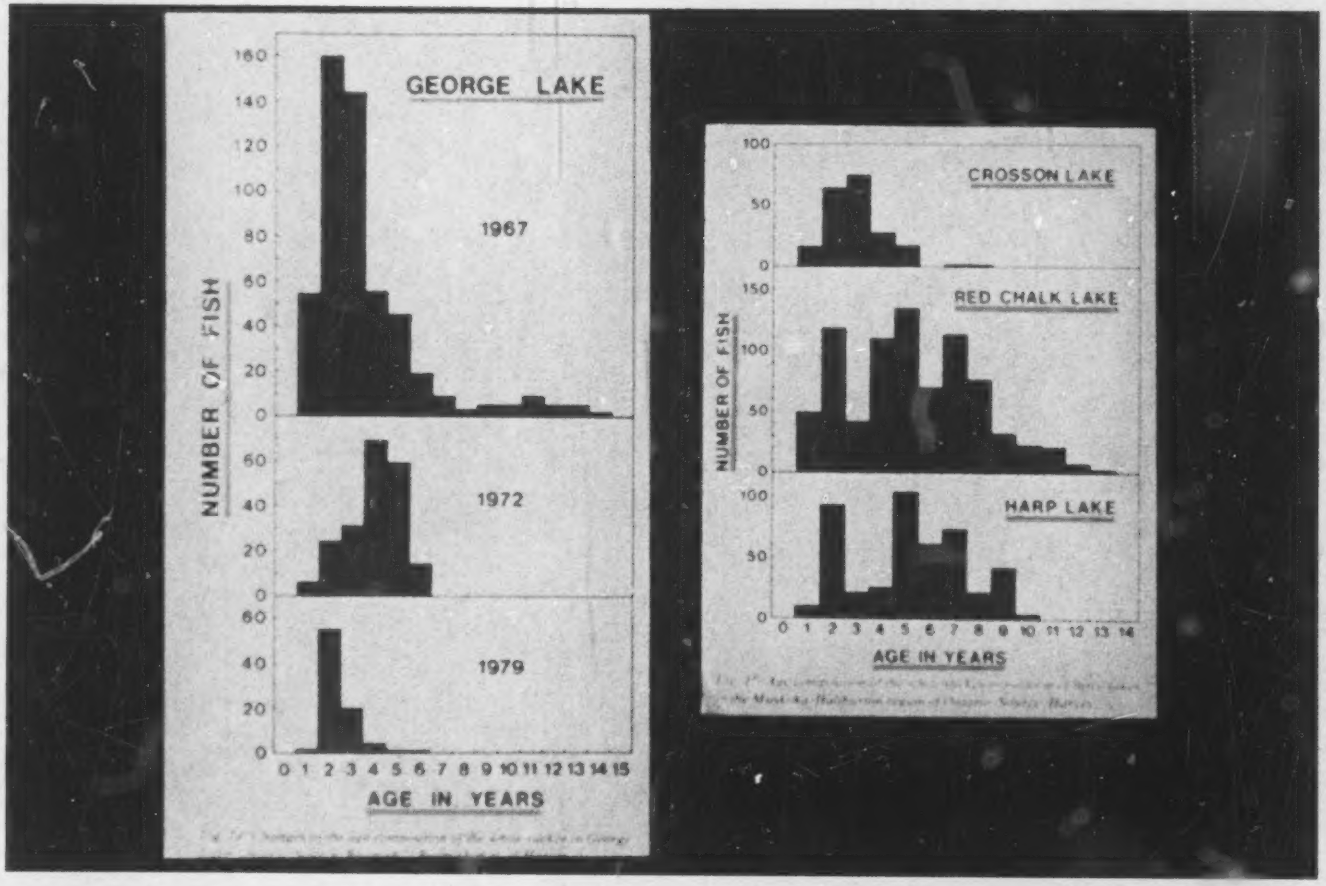
I can only show you data from a few, because that is all we can afford to do the studies in. It costs us many thousands of dollars per year to run one of these calibrated watersheds. The Federal Government is operating four similar facilities spread around over Canada. You are absolutely right that you have to be looking at the right time to see the effects.

The lakes have not been acidified. In other words, in the summertime they are not acidic, but the damage is occurring right now, and it is the gist of our concern that the current acid loadings that are coming down this last winter and again next winter and the rains which fell in August are causing observed, well-documented water quality effects, and we are now documenting the biological responses to those effects.

The fish kill in this particular lake represents a very extreme condition in terms of our understanding of it. We have actually reached the stage of adult fish dying. No doubt there are many younger fish dying, but that is very difficult to see.

Before we leave that liming question, we should point out, if you do lime to protect the stream, you may not do anything to protect the forests and soils at the same time.

[Slide 6 shown. A copy follows:]


GEORGE LAKE
1967
1972
1979
NUMBER OF FISH
160
140
120
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
AGE IN YEARS
CROSSON LAKE
RED CHALK LAKE
HARP LAKE
100
50
150
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Slide 6

Dr. **Brydges**. The next slide, No. 6, goes into some of the data. On the left is a lake near Sudbury in that very, very sensitive rock area that Jim showed in his slide. It is a quartzite rock with no buffering capacity. This lake acidified in a rather rapid time-frame, no doubt led along by the acid loadings from our large mining operation in Sudbury.

In 1967—this is the distribution of the sucker population. There were a lot of young fish and old fish up to 14 years, a fairly healthy situation.

By 1979, for this particular species of fish, all the old fish had disappeared. That is not consistent with some of the conventional thinking that it is the young fish which disappear. For some species of fish and under some stresses—and this has been confirmed by observations in Scandinavia—the older fish disappear. Clearly this population is dying because you eventually get to the point where there are no fish at the age of reproduction, so they would die out.

That is a fairly well-documented case.

Now, on the right is some of the data for our study lakes removed from the Sudbury area. Here is data from three lakes, one with low alkalinity, which is sensitive—two in the area with much higher alkalinity. Look what has happened to the white sucker population. It has a very healthy age class distribution up to 10, 12, 13 years, similar to this.

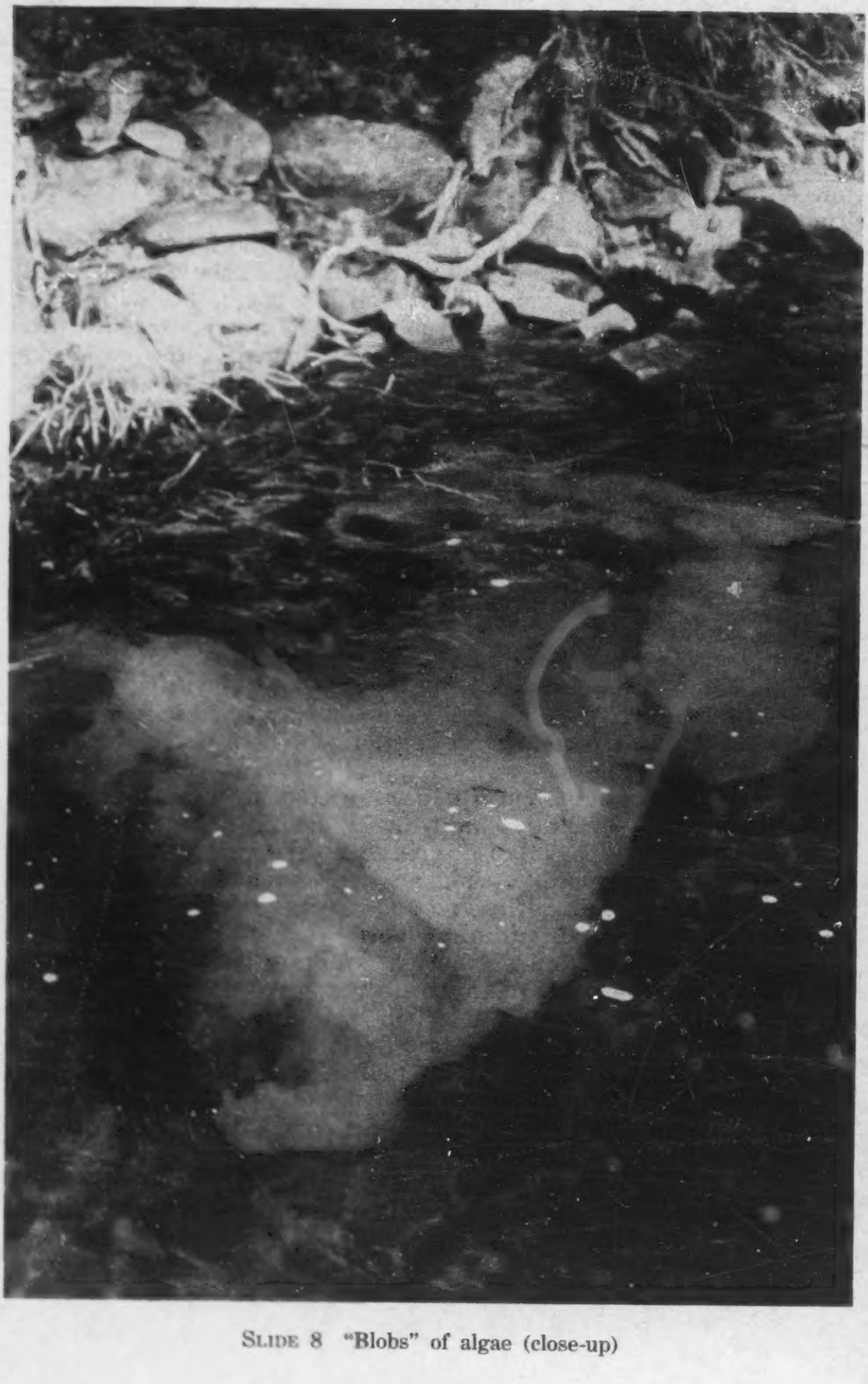
Here is one of our other study lakes, where the old fish have disappeared. This is a comparison in 1 year. This is 1979. This is a comparison through time. We believe what happened through time here is representative of the condition which is occurring right now.

We have the outright fish kill documented in one of our study lakes. This is another study lake which indicates that the fish population is beginning to collapse under the stress of acid rain. This is collapsing as a result of spring pH depression. That lake in the summertime is fairly healthy. You go up there in the spring and the pH is low and the aluminum is high.

The damage to the fish population is one of the main concerns because that is the basis of much of our sport fishing recreation business, and also, when you lose fish in lakes, you really break a lot of the links between the aquatic life and terrestrial organisms.

A lot of birds and mammals eat fish. If you lose fish, that lake becomes rather dead in an ecological sense, and that is why we have now constructed the definition of a dead lake as one with no fish.

In the strictest terms, there are still lots of things growing in dead lakes, but they are not the forms of life you want. (Slide 8 follows:)



SLIDE 8 "Blobs" of algae (close-up)

The next slide, No. 8, shows those blobs up close. These algae forms are unusual. They are not the characteristic forms that you find. We take this as evidence of acid stress, some of these forms are known to be responsive to low pH conditions, and low alkalinity conditions.

We have evidence from local residents that these conditions have increased in the last 5 years. These algal forms are not the normal ones. They will not be supportive of the same types of food change as would be there from the other healthy forms.

Also, one of the forms of algae that grows has a terrible smell and has in fact shut down the recreational use of the lake, which I showed at the beginning. The residents had to literally get out of that lake on a couple of occasions in the past few summers.

People have lived there for 20 years and have never had the problem before the last 5 years.

The next slide shows an example of what happens to one of the algol forms. It actually ends up with a purple degradation product.

This shows what happens when you run your hand through that stuff. I think you can appreciate this is not the sort of thing you want to swim in.

We have the effects of algae coming in. We have the early signs of the complete collapse of the food chain. The algae are at the bottom of the food chain. They feed the zoo plankton and the fish. Once these things shift, the whole thing will collapse.

There is evidence we are at an early stage, we have not acidified the lake, but the current acid loadings are causing disruption of the biological system.

We have nowhere to go but downhill with these lakes. How far we are going downhill is a subject of speculation, but we are going downhill, there is no doubt whatsoever.

The next three slides have an awful lot of numbers on them.

This is data from the memorandum of intent report. My purpose in showing this is to draw attention to the underlined values of loading. They are observed loadings in different areas. All of this goes together to arrive at a target loading for the acid deposition that we think is required to protect the environment.

[Table follows:]

Observed sulphate loadings, and loading values predicted by various methods, required to protect aquatic ecosystems

Source	Loading value kg/ha.yr (SO_4) by wet deposition	Comments
Observed at Hubbard Brook, New York	40	Acidified lakes in the area.
Observed at Dorset, Ontario	30	pH depression causing fish kills.
Observed at Kejimkujik, Nova Scotia	20+	Acidified rivers. Decreased pH in lakes over a 20-30 year period.
Prediction for Nova Scotia Rivers	20	To protect larger rivers.
Dickson prediction	15-17	To protect moderately sensitive waters.
Observed at Kenora	10	No apparent detrimental effects.
pH depression prediction	10	Required to prevent detrimental pH depression in streams and lakes.
Henriksen prediction	20*	To protect lakes above 50 ueq/L cations, i.e. less sensitive lakes.
Henriksen prediction	12*	To protect the most sensitive waters.

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* Assuming 1 meter of rain per year since the model prediction is based on precipitation pH.

Periodic pH Depressions Observed[a] in Streams and Lakes with Different Sulphate Loadings

Location	Annual Sulphate Loading kg/ha.yr(SO_4) by wet deposition	Lowest pH Observed	pH Largest Difference Between Spring pH and summer or winter values	Observed Biological Effect
Panther L. ILWAS Project New York	30	4.8	2.5	No biological data available.
Tovdal R. Norway	40	pH shock suspected but no field measurements taken during the fish kill		Fish Kill (sea trout).
Haliburton Ontario (4 streams)	30	4.1	1.1	No studies.
(lake outflows)	30	4.8	1.3	A year class missing in white sucker populations in one of the lakes. Limited field studies completed.
L. Tinnewatten Sweden (1970)	40	4.2	0.8	Wild population of minnows have disappeared.
Sweden (1972)	40	4.3	1.1	Caged sea trout and minnow experienced 68% and 59% mortality.
Shavers Fork W. Virginia (stream)	30	5.6	0.9	Conditions caused by heavy rain. No biological studies.
Northern Minnesota streams	14	5.8	0.3-1.0	No biological studies.
Plastic Lake Ontario Inlet	30	4.0	1.7	100% mortality of caged rainbow trout.
Outlet	30	5.0	0.7	13% mortality of caged rainbow trout.
Experimental Lakes Area Kenora	10	-	0.2-0.3	No apparent biological effect.

Dr. **Brydges**. You get numbers like 10, 20, 30, 40. Those are approximate numbers in different areas. The numbers with no underlining are numbers derived from various theories, models, observations, and so on from various scientists to arrive at safe levels.

I think it is interesting that we find that the safe levels—12, 20, 10, 15, 17, 20—that 10 to 20 range is coming out from all of the calculations, indicating the likely safe levels.

Now, one of the study areas at the experimental lake there is getting approximately 10 and they are seeing no effects at Kenora.

Here you have 30, which has caused a fish kill. This is in New York in the Adirondacks where you are getting acidified lakes. The point is we have good empirical observations to show at what levels the sulfate loadings are causing problems.

From this we get the number of 20 kilograms per hectare as the maximum the areas should be receiving, a 20 maximum down to perhaps as low as 10.

To reach that 20, you are looking at something like a 50-percent reduction in acid loadings in areas, and if you have to get down as low as 10 to be fully protected, then you are talking about a 75-percent reduction. This has given us a start of between 50- and 75-percent reduction as being required to protect all of the ecosystems.

(Slide 10 follows:)

PERCENTAGE DISTRIBUTION OF LAKES IN EACH ALKALINITY CLASS

COUNTY	ACIDIFIED <0 UEQ/L	EXTREME SENSITIVITY 0-40 UEQ/L	MODERATE SENSITIVITY 40-200 UEQ/L	LOW SENSITIVITY 200-500 UEQ/L	NOT SENSITIVE 500 UEQ/L	NO. OF LAKES SURVEYED
HALIBURTON CO.	0	24	39	22	15	112
MUSKOKA CO.	1	30	61	2	6	115
PARRY SOUND DIST.	5	20	64	10	1	107
PETERBOROUGH CO.	0	4	16	6	74	49

This slide No. 10 is a similar one to show we have drawn in data from around the world. I have indicated our problem right now is not acid lakes, it is acid stress, or spring pH depression. We have assembled all the data we could find to relate the loadings to this spring effect. That was used to derive another number which is consistent with the same observation of about 20.

I won't bore you with the numbers. The point of it is that we have used data and good, hard empirical observations in the field to derive the loadings we are after. We are not saying, "Here is a speculative number. This might do the job." We have solid data to indicate if you get above, you are in trouble.

As you move from 20 to 10 on a sliding scale—all the lakes won't respond exactly the same way—it runs out.

This slide simply backs up what Mr. Bruce said. This is the distribtion of the sensitivity in lakes in four areas. We have set up a scale. These are our Haliburton, Muskoka, and Parry Sound districts. These are percentages—20 percent, 30 percent, 24 percent in the extreme category. You add those together and you get anywhere from 80, 90—whatever that is, percentage of the lakes in the area that are sensitive to the effect of acid rain.

These are the red areas Jim showed on his map.

Peterborough County is in the green area, even there we found a few lakes sensitive, 4 percent, but 74 percent of the lakes are not sensitive. So we can support the observations of sensitivity as a result of the bedrock, as well as the lake chemistry.

This is to remind you this is not what we want in the future. This is the sort of thing we must prevent. Extreme pH's are now occurring in hundreds of thousands of lakes, and this observation will become only too common in the near future if we don't do something about the problem.

Thank you for your attention.

[The prepared statement of Dr. Brydges follows:]

Prepared Statement of Dr. T. G. Brydges

MR BRUCE HAS OUTLINED THE NATURE OF THE LONG RANGE TRANSBOUNDARY AIR POLLUTION PROBLEM AND THE EFFECTS ON SURFACE WATERS. IN MY REMARKS I WILL ADDRESS SOME SPECIFIC AQUATIC CONSEQUENCES OF THE PROBLEM AND SHOW THAT THE PRESENT ACID LOADINGS ARE CAUSING UNACCEPTABLE DAMAGE TO OUR LAKES AND STREAMS.

I WILL BE TABLING A SET OF PHOTOGRAPHS AND GRAPHICS IN SUPPORT OF MY COMMENTS FOR THE COMMITTEE'S REFERENCE.

IN CANADA, AS IN THE UNITED STATES, WE HAVE THOUSANDS OF LAKES IN PRECAMBRIAN ROCK AREAS WHICH ARE BEING AFFECTED BY ACID RAIN. THEY SUPPORT AN EXTENSIVE AND UNIQUE ECO-SYSTEM CONTAINING HUNDREDS OF SPECIES OF FISH, BIRDS, MAMMALS AND OTHER LIFE. THIS IS ONE OF THE GREAT WILDERNESS AREAS OF THE WORLD AND INCLUDES ONE OF OUR MOST IMPORTANT RECREATIONAL AREAS, MUSKOKA-HALIBURTON. THE FIRST SLIDE SHOWS A TYPICAL LAKE IN THIS RESORT AREA.

IN THE SECOND SLIDE YOU WILL SEE ONE OF THE SAMPLING STRUCTURES DESIGNED TO MEASURE FLOW OF WATER INTO AND OUT OF THE LAKES. THE CHEMICAL COMPOSITION OF THE WATER IS FREQUENTLY MEASURED AND THE "SUBSTANCE BUDGETS" FOR THE LAKES ARE CALCULATED. THIS GIVES INFORMATION ON WATER QUALITY, RATES OF CHANGE OF QUALITY AND ON THE FATE OF THE MATERIALS DEPOSITED IN THE LAKES AND WATERSHEDS FROM THE ATMOSPHERE.

THE NEXT SLIDE SHOWS A SAMPLING STRUCTURE (WEIR) IN THE WINTER TIME. SAMPLES ARE COLLECTED FOR 12 MONTHS OF THE YEAR. ACIDS DEPOSITED WITH THE SNOW ACCUMULATE DURING THE WINTER AND DURING SPRING SNOWMELT, A "SHOCK" OF ACID FLOWS THROUGH THE STREAMS RESULTING IN SHORT TERM WATER QUALITY CONDITIONS WHICH CAN BE LETHAL TO FISH.

IN A TYPICAL STREAM AFFECTED BY ACID RAIN, AS THE WATER FLOW INCREASES, THE "SHOCK" LOADING OF ACIDS CAUSES PH TO DECREASE. IN THE EXAMPLE I AM TABLING, THAT DECREASE IS A FULL PH UNIT (I.E. A TEN FOLD INCREASE IN ACID CONTENT OF THE WATER). IT MUST BE EMPHASIZED THAT CURRENT ACID LOADINGS IN SNOW ARE CAUSING THIS PHENOMENON TO OCCUR EACH YEAR. HISTORICAL TRENDS IN ACID LOADING, WHICH ARE THE SUBJECT OF MUCH CONTROVERSY, ARE NOT PARTICULARLY RELEVANT TO THIS OBSERVATION.

THE NEXT SLIDE IS OF ONE OF OUR INTENSIVELY STUDIED LAKES, PLASTIC LAKE. HERE, THE SPRING SNOWMELT HAS CAUSED FISHKILLS OF ADULT FISH IN THE WILD POPULATION. THE EFFECT WAS FURTHER DOCUMENTED THIS PAST SPRING BY PUTTING CAGED FISH IN THE LAKE AT VARIOUS LOCATIONS. MORTALITY WAS 100% IN 2 DAYS NEAR ONE INLET COMPARED TO NO MORTALITY IN 4 DAYS IN A CONTROL LAKE OF HIGHER PH.

THE EFFECTS OF ACIDIC WATER ON FISH POPULATIONS ARE MANY AND VARIED. IN ADDITION TO LETHAL TOXIC EFFECTS, LOSS OF ALL FISH IN LAKES DUE TO REPRODUCTIVE FAILURE HAS BEEN OBSERVED. WE CAN SEE FURTHER EVIDENCE OF EFFECTS OF ACID STRESS ON THE FISH POPULATION BY COMPARING LAKES OF VARYING SENSITIVITY. AS YOU WILL SEE, THE WHITE SUCKER POPULATION IN CROSSON LAKE HAS THE SAME AGE CLASS DISTRIBUTION AS GEORGE LAKE HAD WHEN THE PH DECLINED. WE ASSUME THAT CROSSON LAKE IS EXPERIENCING DAMAGE FROM THE SHORT TERM WATER QUALITY EFFECTS. THIS TENDENCY TOWARD YOUNGER FISH, WHICH CAN LEAD TO COMPLETE LOSS OF THE POPULATION, HAS BEEN OBSERVED IN STUDY LAKES IN SCANDINAVIA AS WELL.

FURTHER EVIDENCE OF BIOLOGICAL EFFECTS IN ACID STRESSED LAKES COMES FROM OBSERVATION OF ALGAE GROWTH. ONE OF THE SYMPTOMS OF ACIDIC LAKES AND STREAMS IS GROWTH OF CERTAIN GREEN FILAMENTOUS ALGAE. THESE ALGAE FORM VERY DENSE GROWTHS IN SOME ACIDIC LAKES IN SCANDINAVIA AND ONTARIO. IT HAS BEEN ONE OF THE FIRST "INVADERS" OF MAN-MADE STREAM CHANNELS AND LAKE ENCLOSURES DURING ARTIFICIAL ACIDIFICATION EXPERIMENTS. OBVIOUS CONSEQUENCES OF THIS GROWTH INCLUDE LOSS OF SWIMMING OPPORTUNITIES, GENERAL DEPRECIATION OF SHORELINE VALUES AND DISRUPTION OF THE AQUATIC FOOD CHAIN.

WHILE SOME HIGHLY ACIDIC LAKES (PH 4.2 - 5.5) IN THE SUDBURY AREA OF ONTARIO SUPPORT EXCESSIVE AMOUNTS OF THESE ALGAE, SEVERAL LESS ACIDIC LAKES IN MUSKOKA-HALIBURTON WITH PH VALUES OF 5.3 - 6.0 (E.G. LEONARD LAKE, PLASTIC LAKE, HEENEY LAKE) CONTAIN DENSITIES OF THESE PLANTS WHICH ALREADY HINDER RECREATIONAL USE OF THE LAKES.

SEVERAL SLIDES AND PHOTOGRAPHS ILLUSTRATE SOME OF THE OBSERVATIONS WHICH WE HAVE MADE IN THE ACID STRESSED LAKES IN THE MUSKOKA-HALIBURTON AREA.

I WILL BRIEFLY ILLUSTRATE SOME OF THE KINDS OF DATA LEADING TO THE TARGET LOADINGS REQUIRED TO PREVENT DAMAGE WHICH MR. BRUCE REFERRED TO.

THE FIRST TABLE SHOWS CURRENT SULPHATE LOADINGS AND SOME EFFECTS ON SURFACE WATERS IN SEVERAL OF THE STUDY AREAS IN NORTH AMERICA. OBSERVED LOADINGS WHICH DO NOT CAUSE EFFECTS AS DERIVED BY SEVERAL METHODS ARE INCLUDED ON THE TABLE. IT IS CLEAR THAT THE 20 KG/HA.YR. FIGURE APPEARS TO BE THE VALUE WHICH BEGINS TO REDUCE THE SURFACE WATER EFFECTS. DEPOSITION VALUES BELOW THIS WOULD CAUSE LESS AND LESS DAMAGE UNTIL AT A VALUE OF 10 KG/HA.YR. THERE APPEARS TO BE LITTLE OR NO EVIDENCE OF ANY BIOLOGICAL DAMAGE TO SURFACE WATERS. THESE VALUES IMPLY DAMAGE BY ACIDIFICATION IN THE LONG TERM.

HOWEVER, AS WE HAVE SHOWN, OUR MAIN CONCERN IS FOR THE IMMEDIATE DAMAGES CAUSED BY THE SPRING DEPRESSION OF PH WHICH WILL LIKELY OCCUR FOR MANY YEARS BEFORE THE WATERS BECOME ACIDIFIED ALL YEAR LONG.

A SECOND TABLE HAS BEEN DEVELOPED ON THE SAME PRINCIPLE AS THE FIRST TABLE, WHICH COMPARES OBSERVED EFFECTS TO OBSERVED SULPHATE LOADINGS. IT AGAIN IS CONCLUDED THAT THE 10 KG/HA·YR. LOADING APPEARS TO BE FULLY PROTECTIVE OF SURFACE WATERS WHILE THE CURRENT LOADINGS IN MANY AREAS OF MORE THAN 30 KG/HA·YR ARE CLEARLY UNACCEPTABLE.

WHILE NOT FULLY DOCUMENTED, IT CAN BE EXPECTED THAT LOADINGS OF 20 KG/HA·YR. WOULD GREATLY REDUCE THE DEGREE OF SPRING PH DEPRESSION AND MAY BE PROTECTIVE OF ALL BUT THE MOST SENSITIVE SURFACE WATERS.

FINALLY, I WANT TO INDICATE OUR UNDERSTANDING OF THE EXTENT OF DAMAGE TO OUR LAKES.

CLEARLY, THE DETAILED LAKE STUDIES I HAVE DISCUSSED ARE VERY COSTLY IN TIME AND RESOURCES. DATA OF SUCH DETAIL CAN ONLY BE COLLECTED IN A SMALL NUMBER OF LAKES. IT IS THEN NECESSARY TO EXTRAPOLATE THESE OBSERVED EFFECTS TO OTHER LAKES WHERE WE HAVE VERY LIMITED DATA.

WE FEEL THAT THE LAKE ALKALINITY IS A GOOD MEASURE OF THE LAKE'S RESISTANCE OR SENSITIVITY TO EFFECTS OF ACID DEPOSITION.

Mr. SCHEUER. In the interest of relevance, let me say that the Members of Congress with me here—they are all Republicans, and they are mostly representing rural areas afflicted by acid rain in the United States; most of them from New York, except my colleague Jim Sensenbrenner from Wisconsin, and he is extremely well-informed on this subject.

I think we all have had our level of consciousness raised on the danger and the threat. I hope in the next 2 hours before we leave we will be addressing some of the public policies that are presented to the parliamentarians of our two countries, parliamentarians who have a pretty rough and ready scientific basis that has stimulated their level of consciousness.

The question is what do we do about it. There are a number of policy questions we have to face in the United States, and let me just throw them at you. We are not scientists, we write laws and produce public policy.

As you all know—and it doesn't bear a great deal of repetition—we had an election last November. We elected an administration that is dedicated to rolling back the level of regulation, rolling back the level of Government interference with the privileged economy, rolling back the level of Government interference in our lives.

You are familiar with the things that the Secretary of the Interior, James Watt, has been saying over the last 8 months. You know this is a part of the gestalt in which we have to function every day. This is the reality for us, and that is not going to change for the next 3 or 4 years.

That presents us with some practical problems. We are concerned about environmental degradation—acid rain. What do we do about it in this frame of reference?

We know that the United States plays a minor part in world production of acid rain. There are maybe 140 million tons of SO_2 spewing out all over the world for which we are responsible for maybe one-fifth of all of the pollutants.

What public policy can the United States and Canada push together in the total family of nations to reduce the total global emissions of SO_2 for starts?

In our own country and in Canada who pays? Do we impose costs upon the polluters and their customers by mandating a much higher degree of antipollutant technology, or do we have some kind of national program where we provide loans and grants to polluters to reduce pollution, so in effect all of the taxpayers pay?

Or do we say, "Well, people in the receiving areas are going to pay," or "The Canadians will pay for Ohio polluting," or "The U.S. will pay for Sudbury polluting."

You talk about coal washing. We heard yesterday about coal scrubbing. Is our data base sufficient to prove that we can establish reasonably clear—positive cost-effectiveness criteria for mandating coal washing?

Do we have a data base sufficient to at least say the minimum low technology, low cost antipollution systems ought to be applied universally? Maybe we can prove there is adequate cost-effectiveness data to mandate scrubbers now, from the point of view of the environment.

We have some data that some of the utilities and some of the industrial installations are finding there is adequate cost information to justify high cost scrubbers now. Not from the point of view of the environment, but from the point of view of the efficiency of their combustion processes, that it pays them to save fuel, to install the scrubbers.

What kind of a data base should we be accruing in the next 3 to 5 years to justify the next incremental level of regulation? Do we have a sufficient data base now to mandate low technology—moderate coal washing, for example—and what kind of data base should we be looking for in the future in incremental steps to justify further incremental levels of antipolluting systems?

The Reagan administration has engaged in a lot of zero-based budgeting. They have wiped the slate clean. In a lot of cases, I think that was well-justified. It is hurting some environmental programs we all care about, and this is the reality that we have to deal with.

I hope in the next hour or so we will be fine-tuning our thinking, we will be applying the available scientific base that you have brilliantly presented, your well-qualified and well-trained experts, and you will help us bite the bullet on some of these public policy issues we have to face.

Absent this kind of hard data justifying specific regulatory programs, I am afraid that we are in for a period of 3¼ years of very great frustration, as frustrating to many of us as it is to you.

To work ourselves out of this negative environment we have to focus our thinking and come up with some pretty hardnosed analyses that the pace in terms of our national productivity and in terms of identifiable returns on investment to agriculture step further in our regulatory program.

I suspect, without knowing it, that Canada is taking up some of these agonizing questions, too. You have the world's largest polluter in your Sudbury installation. It is still polluting.

I am sure you have plans to do something about it over the long pull, but the fact it is still polluting and the fact work is not going on right now indicates that you haven't been able to satisfy yourselves that the application of the highest technology, the highest state of the art, now, provides a satisfactory payoff.

We are both in the same boat in that respect, and I hope sometime in the next couple of hours we will be addressing ourselves to these public policy questions that both your Parliamentarians and Members of Congress have to address in the next couple of years.

Mr. CARNEY. Will the gentleman yield?

Mr. SCHEUER. Of course I will be happy to yield.

Mr. CARNEY. I think everyone knows, at least in our Congress, that the chairman of this subcommittee is a leader in this field of acid rain, and we have a Senator from the great State of New York who has great concern about acid rain and has been working toward a solution of that.

Some of you testified before hearings held by Senator Moynihan. I would simply like to say one of the problems that we have had—and I think no one has declared the frustrations as much as the chairman of this committee—is that we can't get our Congress to react. He has been fighting this problem.

I might make a reference in a Congress two-thirds controlled by his own party, up until January, and he has been fighting it for years, and a Senate that was controlled by his party 59 to 41. We have not controlled the Congress of the United States for 26 years.

This is not going to do us any good. What we need is technical answers to convince our colleagues that we have clearly identified the source of the pollution and clearly identified its destructive end result.

One of the things that we can do to justify that is to point out to them that this is not something that is parochial, it is not something that is United States versus or New York State versus Kentucky or New York State versus Ohio.

It is a problem that goes far beyond State boundaries, as you gentlemen have clearly shown. It is something that is international in scope and it is not just between the United States and Canada.

What we have to do if we are going to move forward, we have to find technical answers so we in legislative bodies can support our arguments and create legislation or regulation that will stand the litmus test of our Federal courts and stand the litmus tests of our people that we represent.

I think the best thing we could do right now is move on with this technical briefing and try to identify that. I can only say that Mr. Bruce's and Dr. Brydges' presentations were excellent, and I would like to just make a couple of points and ask Dr. Brydges a couple of questions, if I may at this point, Mr. Chairman.

Dr. Brydges, your presentation was dealing primarily with surface waters, when you were making the evaluation. I think that is somewhat significant inasmuch as of rècent times we have some confusion as to saturation.

In yesterday's hearing we talked about the saturation of acid rain, but when you deal with your testing, you are dealing with the acid level of lakes and of streams on the ground so that the impact of those lakes and streams are being affected both by acid rain and solids, particulates that fall out of the air and eventually get into the ecosystem. I think that is very, very significant.

One of the problems that I fear, going back to my collagues, was going back and saying: "If we use the parameters of measuring acid rain, we are not going to find significant results, with a cutback of even 50 percent of emissions, because the air is so totally saturated."

But your data base deals with both parameters, the solids and precipitation, and that can be of significant value to us. I would like to, and I would hope that we can have your data base to use, not so much in argument, but for a spirit of information, giving it to our colleagues, who I am sure want to protect their constituencies, and try to give us evidence that indeed they are not the cause of all these problems.

Dr. **Brydges**. The calibrated watershed approach, or what comes down and what comes out, give us a shot at the item. We find numerically we get more sulfur coming out of the watershed than we measure going in.

The degree to which that is the result of the dry deposition is still open, but at least the data is there and the data is close to

Sudbury, where we know we have a higher sulfur dioxide amount in the air.

We clearly identify these dry deposition sources. The lake itself is the ultimate collector of the problem. You are certainly welcome to all our information.

Mr. CARNEY. In addition to that, have you traced the problems associated with—I am not a technical person—the changes, the chemical changes that have produced aluminium in the water, the leaching of the aluminium because the acidity level changes?

Do you have studies of any type to identify that problem as well?

Dr. BRYDGES. Yes. That data comes from the same approach. A lot of that is very new information. Not much has been published yet, but we are looking at that. The amount of aluminium, for instance, in the fish kill.

The fish are analyzed for aluminium and some have approximately the same amount as fish from other identified fish kills in Scandinavia and so on. It is a strong part of the technical argument.

Mr. CARNEY. Quite frankly, not many people know or realize that this is another byproduct of the acid precipitation problem.

Mr. BRUCE. Mr. Chairman, I would like to comment very briefly on the question of what kind of a reduction in deposition would result from cuts in emissions, and the question of supersaturation of the atmosphere over this part of the world.

We do have a good deal of scientific evidence that we would be happy to make available. It is very complex atmospheric chemistry and meteorology, but I would suggest that some of the fears that you may have been exposed to are unfounded.

Basically, we think that the laws of gravity continue to operate, and what goes up must come down, and that every experience we have had in pollution control measures in the atmosphere and in lakes and river systems would suggest if we cut back on the emissions, we are going to see a positive effect on reducing the pollution of ecosystems.

Mr. CARNEY. I totally agree with you, Mr. Bruce, but the point I was trying to bring out is the parameters that are traditionally used in the United States—perhaps not among the scientific communities, but among the members of the political community—is the acidity level of precipitation, and that in itself is playing with half a loaf of bread, and that one particular half a loaf of bread is not going to show any appreciable change in the problems that we are suffering here in the Adirondack region or, indeed, parts of Canada.

My understanding is it will show some change if we reduce our emissions in the northern and easternmost parts of your great Nation. But closer to the source of pollution, it doesn't show on a chart, and then we will be subject to criticism from our colleagues.

On the other hand, the type of information that Dr. Brydges is bringing to our attention will show immediate changes because we are dealing with both what comes down through the phenomenon of acid precipitation and what comes down through Newton's theory of gravity.

That is important to us because I don't want someone campaigning against me saying that I raised the cost to generate electricity and I am running around in sneakers with a butterfly net and there is absolutely nothing to reduce the amount of acid and rain. Perhaps it won't if we only reduce the amount of emissions to a degree that will not show that.

I say for every action we take in the reduction of emissions from a source point, we can find and identify positive reactions from the types of studies dealing with the lake waters and soil conditions as opposed to just studying the pH values of precipitation. That is why I think that is significant.

Mr. **Scheuer**. Let me emphasize what I was saying. We passed a point in our country as a practical political matter of fact where it is sufficient for us to say what goes up has to come down, and therefore we should cut down what goes up. That is not acceptable because we can't identify where it comes down or that it will help very much in reducing acidity where it comes down.

Your own Sudbury plant is a case in point because, as I understand it, it was closed down for about 6 months when the workers were out on strike, and there was no identifiable reduction in acid rain in any immediate areas surrounding it. That puzzled all of us and it compounded our problem.

We have to prove if we engage in a certain level of cost there is going to be an identifiable level of benefits flowing from there, not fuzzy, not trivial, but significant and identifiable.

This is a very complicated problem. I guess the scientists both in America and Canada are enormously frustrated by it, but this is the kind of evidence we have to produce in our political system if we are going to move.

We are looking to the entire fraternity of scientists on both sides of that national border to help us produce the evidence that we need to act.

As an emotional matter, most of us are convinced we have to act, but it is a question of convincing an unsympathetic administration and unsympathetic business community that has a lot of clout with this Congress and with this administration, that it is clearly identifiable in the business community's interest to engage in *x* level of expenditure to produce *y* level of benefits. If we can't do that, we are in trouble.

As a matter of fact, we had a competent scientist telling us yesterday that we don't have the data to justify treating the sources of pollution and we probably ought to just try and keep the patient alive and treat the patient—lime the lakes and so forth—we should just identify where the worst polluting problems come from and ameliorate them somewhat giving up on the sources of pollution.

I don't think most of us buy that, but that was adduced by a scientist yesterday, and it is part of the facts of life we have to deal with.

Mr. **Bruce**. I am sure we can give you the evidence and show you we know how to move from a source region to a receptor and show what effects a cutback in the source can have in the receptor area.

In connection with the Sudbury case, Dr. Volkenburgh could speak to that.

Mr. **Fraser**. I am resisting the temptation to become an American politician, but I just want to make a brief comment.

I want to point out to everyone in the room, including my colleagues in Congress, that you have your problems, which of course it is your responsibility to resolve, and it is not for us to tell you how to do it, but I can say on behalf of both of my colleagues here of different parties that much of the resistance that you are facing on this issue in your country was also there in our country as recently as 2 years ago.

What has happened in Canada is that the understanding of the issue has become so well-known to a large part of the population, and the political will of all parties who are there to do something about it, as a consequence, some of the difficulties you have described are not in the same degree in Canada as here.

There is not a political party in Canada that will for one moment defend in even a passing reference any suggestion that this problem must be addressed, and must not be addressed most aggressively.

It happens to be a fact in our largest province, which is Ontario, the understanding of acid rain is now at an 80-percent level among the population. It is nothing like that in the United States. A part of our purpose, of course, is to raise that level of appreciation in your own country.

I just want to quote for you something that William N. Poundstone said about a year ago. He is the executive vice president of Consolidation Coal Co. He was testifying before the U.S. Senate Energy and Natural Resources Committee. He said this:

> It is not clear that acid precipitation does in fact cause acidification of lakes, particularly in the eastern United States, or cause other severe ecological damage. It is also unclear that coal burning by the utilities is a major cause of increased acidity and rain.

He went on.

Now, I think if one observes the debate over the last year, you will find not very many people are repeating what Mr. Poundstone declared so affirmatively in 1980. The debate now is getting to cause and reception and how much we have to reduce to do something about it.

All I am saying is, while a year ago we were having to take on Mr. Poundstone head-on in that assertion, now we are getting into a second stage because that first assertion is dying away.

I suggest to all of our American friends that as understanding of this situation increases, some of the difficulties that your chairman has outlined so vividly will also, I think, diminish.

Mr. **Martin**. Perhaps I am remiss in not having an answer to this, but reference was made to the Canadian Clean Air Act, and I suppose that makes sense only in the context of how it relates to our Clean Air Act as it is presently constituted.

Is anyone on the panel prepared to contrast the two laws and the standard for emission? I would assume that, given the awareness, that your act would be something of a model for what ours should be.

Is that true?

Mr. **Rejhon**. I wouldn't think so, Mr. Martin.

The names of our Clean Air Acts are identical, but after that they get very different. This is for reasons which have less to do with pollution control than with the constitutional and legal systems of our two countries; but also, differences in the major sources of the kind of pollution we are concerned about.

Under our system, provinces have principal authority for setting most standards. The Federal Clean Air Act, therefore, in many respects is merely indicative—though we have authority to deal with health related and international pollution. That is a pretty major difference. We have geographic subdivisions which are larger than some of yours.

Also, when you look at the major kinds of sources, your biggest source of the pollutants we are concerned about, are the power generating industry, specifically the coal-fired powerplants. In our case, it is the smelters that are the principal contributors.

So I don't think you can draw a simple comparison.

If you were to say, "How many scrubbers do you have in Canada" as an indication of how serious we are, the short answer is: We don't have any. The long answer is: If we are to deal rationally with reducing the kind of pollution we are concerned about, we, in Canada, have first of all got to zero in on our smelters, whereas obviously in your case you have concentrate initially on your coal-fired powerplants. So again we can't draw a simple comparison.

There has been a good comparative analysis done of our clean air laws by the Environmental Law Institute in Washington, and I would commend it to your attention. I think it is an excellent study which sets out clearly the differences in our two laws, the differences in the standard setting processes, and some reasons why those differences are inevitable even though what comes out at the other end can be very similar.

In other words, our commitment to reducing pollution is very similar even though the way we go about it is necessarily different.

Mr. **Martin**. I have lived near the Canadian border all my life. When I went to the parliamentary group, the first session brought up the problems that you have, and that was very educational.

I understand the central government is only now getting some kind of authority to relate to us here. But Mr. Fraser is from British Columbia. I don't know whether you would suggest that as a high impact area for acid rain. Can you give me an idea, as among the province laws and their standards collectively, is it more stringent than our Clean Air Act is? Could you make any generalization?

Mr. **Rejhon**. There are substantial differences in standards. Some of ours are weaker than yours, some are more stringent in some areas.

I think it is important in the context of this discussion to remember that acid rain is not necessarily an air pollutant. Air is simply the medium of transportation and the problem only arises when the pollutants hit the ground.

So it seems to us we really can't deal with this problem in terms of ambient air quality in, for example, the Adirondacks or in Ontario.

Air quality is not the issue. The amount of pollutants that create acid rain are in any one day usually very, very low. Obviously you can't compare the air quality here with the air quality in downtown Windsor, or downtown Detroit.

Mr. **Martin**. That is what I am talking about, how much goes into the air and what the controls are in your provinces generally as to what is in the air as contrasted with our Clean Air Act which tries to control what is in the air.

Mr. **Manson**. I think we have to go back and stress the difference in the sources of the problem. If you go to the smelters, they are controlled to a far more stringent level than are your smelters.

Our powerplants, some are cleaner than yours; some are dirtier than yours. It depends on the area. When you go through the regulations you have federally, some of them where the problem is a specific problem in Canada are more stringent than yours.

For example, we have an asbestos problem in Quebec. We have stringent asbestos regulations, that kind of thing. So you can't generalize.

The only other general comment I will offer—and I will get to it in my statement, this is a generalization—is that since 1965 emissions in eastern Canada have decreased significantly while in the Eastern United States they are stable. I suppose I could say our requirements are much more stringent. We are going down.

Mr. **Blackburn**. We have an extreme example of the nature of acid rain in North America. We should keep in mind that INCO, even though it is still the No. 1 polluter of acid rain, has decreased emissions by 70 percent in the last 9 years.

Mr. **Sensenbrenner**. I am puzzled by your last statement that in Canada emissions have decreased and in the United States they have remained stable in the time since 1965. Despite the fact there has not been an increase on either side of the border, the acid rain problem has compounded to reach a critical level in certain parts of our countries.

As we are gropping for a cost-effective solution, it seems to me that kind of statistical evidence certainly will not help us in the problem solving situation that we have on this side of the border.

Mr. **Rejhon**. One of the complications in getting a handle on this problem is its cumulative nature. It is one that has to be around for a long time before you begin to see the effects.

As you have been told by Dr. Brydges, the current loadings on some of the sensitive systems are two to three times greater than what those systems can withstand. That means you can get a fair amount of acid rain falling in an area for many years before you see a thing.

As long as the buffering capacity and the natural flushing of the system get rid of the acid or neutralize the acid for a number of years, you see no effects. Things are happening because you are losing buffering capacity, that is, the acid neutralizing capacity, but nothing can be easily seen. It is only when you get to the point where things are starting to collapse, starting to really give way, that you see any effect.

Mr. **Sensenbrenner**. That brings me to my next question. We are at the point of collapse. I think that is generally agreed. But even if we collectively clean up our act, is it too late to solve the problem?

Mr. **Rejhon**. It depends on how you define the problem. Some of the lakes that are gone perhaps will remain essentially dead, but what we have here, it seems to us, is a kind of canary in a coal mine analogy, insofar as the lakes that are gone are concerned.

They give us an opportunity because we can see what has happened to them. It gives us an opportunity to start reducing the stress on the systems that are still relatively healthy to try to save them.

For example, in Wisconsin I am not aware that you have any evidence that any of the lakes have been stressed so badly that they are in immediate danger. From the point of view of the State of Wisconsin and its tourist industry, it seems to me the evidence we now have in the Adirondacks and in Ontario provide an opportunity to insure that what has already happened here is not going to happen in 5, 10 or 15 years there.

Mr. **Sensenbrenner**. Again going back to the statistics expressed a little bit earlier, there is not an increase in stress through environmental regulations between the United States and Canada, and yet we have them looking toward a precipice in 5 more years, even though there has been a decrease on our side of the border and your side.

Mr. **Rejhon**. What we are talking about, to use that analogy, if all the sensitive lakes are likened to individual vehicles driving toward this precipice, then if we argue about whether things are getting worse or better, we are arguing about whether vehicles are accelerating or decelerating.

What is important is they are driving down the road and many will fall over the precipice one by one. Whether somebody is slowing down or speeding up a little bit is not as important as the fact that they are all moving down that road.

I think you will find the next presentation interesting. Here is where much of the criticism is being leveled at scientists in both our countries; that is, the atmospheric side.

Clearly that is the area where there is perhaps more uncertainty than elsewhere, but I think Dr. Van Volkenburgh will show you, insofar as atmospheric transport and transformation are concerned, that there is quite a lot that we already know.

Dr. Van Volkenburgh.

STATEMENT OF GREGG VAN VOLKENBURGH

Mr. **Van Volkenburgh**. I apologize for the lack of slides for the audience. For the committee, I have some handouts which I will be referring to.

I want to talk about three areas in my remarks: First a discussion of atmospheric chemistry. Second a discussion of the role of meteorology and the transport and transformation and deposition of materials tied into long-range transport. Third, a discussion about some of the techniques we have to identify where these materials come from, how they are transported, the relationship between emission regions and receptor regions. There are a variety of techniques available to develop these relationship, not just one technique.

As far as a detailed description of all of these different areas is concerned, I think there was a comment earlier about examining Canadian studies and wanting to know more about the Canadian studies. I would suggest that the technical working group reports produced as part of the memorandum of intent, are a good starting point to do this. Much Canadian research is being reported there.

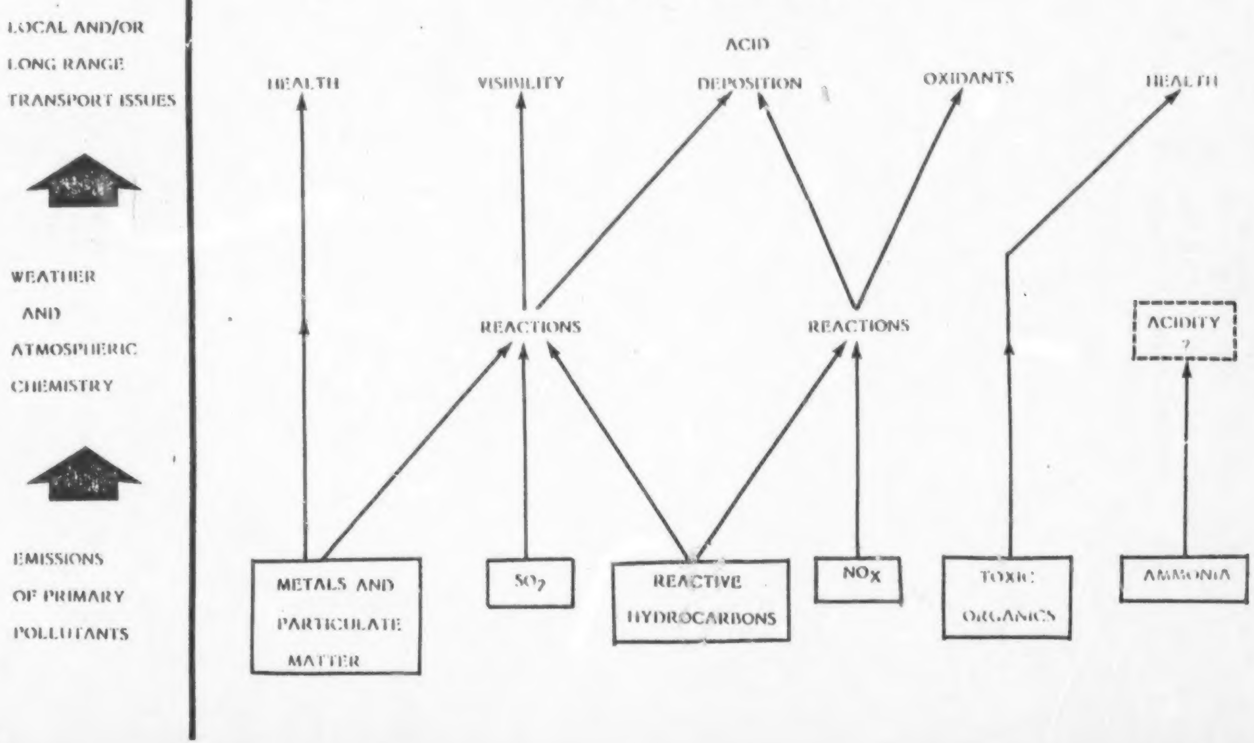
There is a phase 1 report for all technical, legal groups. Here, for group 2, is the summary report for phase 2. There are 12 other reports as part of group 2's effort which are literally about 1 foot high. Group 2 is one group reporting exercise. There are other groups, such as the effects group and group 3(b), which discusses control technology and emissions.

An enormous amount of information is being collected and being reviewed critically by scientists for both countries, and this information is available. If after reading that you want to know more about Canadian research, I don't think there is any scientist in Canada who would not like to talk to you, perhaps longer than you would like, about that information.

Starting off in the first area of my remarks and talking about atmospheric chemistry, in the first page of the handout (see fig. 1) is a schematic diagram to illustrate the principal links between the emitted materials.

FIGURE 1:

RELATIONSHIP BETWEEN PRIMARY POLLUTANTS AND LONG RANGE TRANSPORT ISSUES


LOCAL AND/OR LONG RANGE TRANSPORT ISSUES
WEATHER AND ATMOSPHERIC CHEMISTRY
EMISSIONS OF PRIMARY POLLUTANTS
HEALTH
VISIBILITY
ACID DEPOSITION
OXIDANTS
HEALTH
REACTIONS
REACTIONS
ACIDITY ?
METALS AND PARTICULATE MATTER
SO_2
REACTIVE HYDROCARBONS
NO_x
TOXIC ORGANICS
AMMONIA

Emitted materials are substances like metals and particulate matter, sulfur dioxide, or hydrocarbons which photochemically react. The latter can consist of substances such as gasoline vapors, paint thinners, or industrial solvents. Other emissions possible are nitrogen oxides organic materials such as PCB's, or ammonia which could be emitted in urban areas or agricultural areas.

If you think of those emissions as starting materials, how are they connected with the transport issues that we are looking at, such as health, visibility, acid deposition, oxidants? That is where the role of atmospheric chemistry and meteorolgy come to the fore.

The diagram illustrates the fact that there are materials associated primarily with certain issues. We know that already. For instance, sulfur dioxide is certainly associated with visibility reduction and is certainly associated with acid deposition.

Hydrocarbons have been found to be associated with accelerated formation of sulfates from sulfur dioxide. Sulfates are tied to acid deposition and visibility degradation. Hydrocarbons also influence the formation of oxidants. Nitrogen oxides are certainly associated with the formation of oxidants and with the formation of acid deposition.

Organic materials which do not react with sunlight can be transported through the atmosphere and may pose a health concern, or be deposited into lakes. There is not too much known about ammonia emissions but there are signs that in terms of the atmosphere, it can neutralize acids. However, if ammonia is deposited into ecosystems, it can also serve as an acidifying agent, so there is a compound which can behave in two different ways, depending on where it is.

I think this diagram illustrates that is possible to know the basic facts about some of these materials, and start control actions for these materials if they pose an environmental hazard. We do not need to wait until we know everything about everything. This is a very important point in terms of designing control programs and putting them into practice, certainly in terms of what Canadians would like to see in terms of control programs. We are concerned about all of those long-range transport issues at the top of the page—health, visibility, acid deposition, and oxidants; however, the primary one, the one we are waving the red flag about, is the acid deposition issue. We see effects from it now, and it is one we feel enough is known about to take action, because of the magnitude of the problem.

If I may, from now on, I will switch to acid rain as the term, but I am technically talking about acid rain in terms of both wet and dry removal from the atmosphere.

What causes acid rain? The starting materials for the formation of acid rain are largely sulfur dioxide and nitrogen dioxides. These materials are emitted in large quantities from man-made sources in Eastern North America. You have seen pictures of how those emissions are distributed in Mr. Bruce's presentation.

In the atmosphere, other materials such as metals, metal-based particles, urban particulate matter, carbon-based particles, hydrocarbon materials, water vapor and other gases produced in the atmosphere, and sunlight, all help the sulfur dioxide and nitrogen dioxides change form.

One comment I can make with reference to Mr. Scheuer's remarks about recommendations or as to what can be done, is that I think a realization among the scientific community exists that because of this chemical soup-mix, long-range transport issues are interlinked.

For instance, a study of hydrocarbons in the formation of oxidants should not be the only focus of work for these materials. One should also look at how hydrocarbons are emitted into the atmosphere and how they participate in the formation of acid rain.

I am not sure that the U.S. acid precipitation assessment program formally recognizes that. Integration of acid rain research has to include a lot of different studies in terms of program activities, and linkage to other long-range transport phenomena should be part of the program.

As a second comment, I sometimes have the impression as an atmospheric scientist that some people seem to think that emissions just go up there, stay there, and float around forever.

That is just not the case. There is general scientific consensus that many of these compounds put into the atmosphere may fall out of the atmosphere in a matter of hours. Some compounds, however, on average can remain in the atmosphere for several days, and maybe a very small fraction of the time, they may stay up for a week or two if they are in the upper atmosphere. The materials are certainly not being emitted and hanging around up there forever, and not coming down. If this were so, we all would have choked to death by now. For example, one can consider emissions of about 50 million tons of SO_2 and nitrogen oxide per year in North America. If that material did not come down, you would have a huge influx of material which would keep building up in the atmosphere and dissipate all over the world's air spaces. Concentrations of this material would eventually build up everywhere in the world. Since this is not happening, we can conclude that materials that are put into the atmosphere have to be coming down in fairly short-time scales. It is difficult to think of the atmosphere as being saturated.

Now, getting more to the actual chemistry instead of the interrelationship of the species, if you will look at the next handout—see figure 2—I would like to explain some aspects of atmospheric chemistry and take some of the mystery out of this field.

Fig.2: ATMOSPHERIC REACTIONS OF SO_2

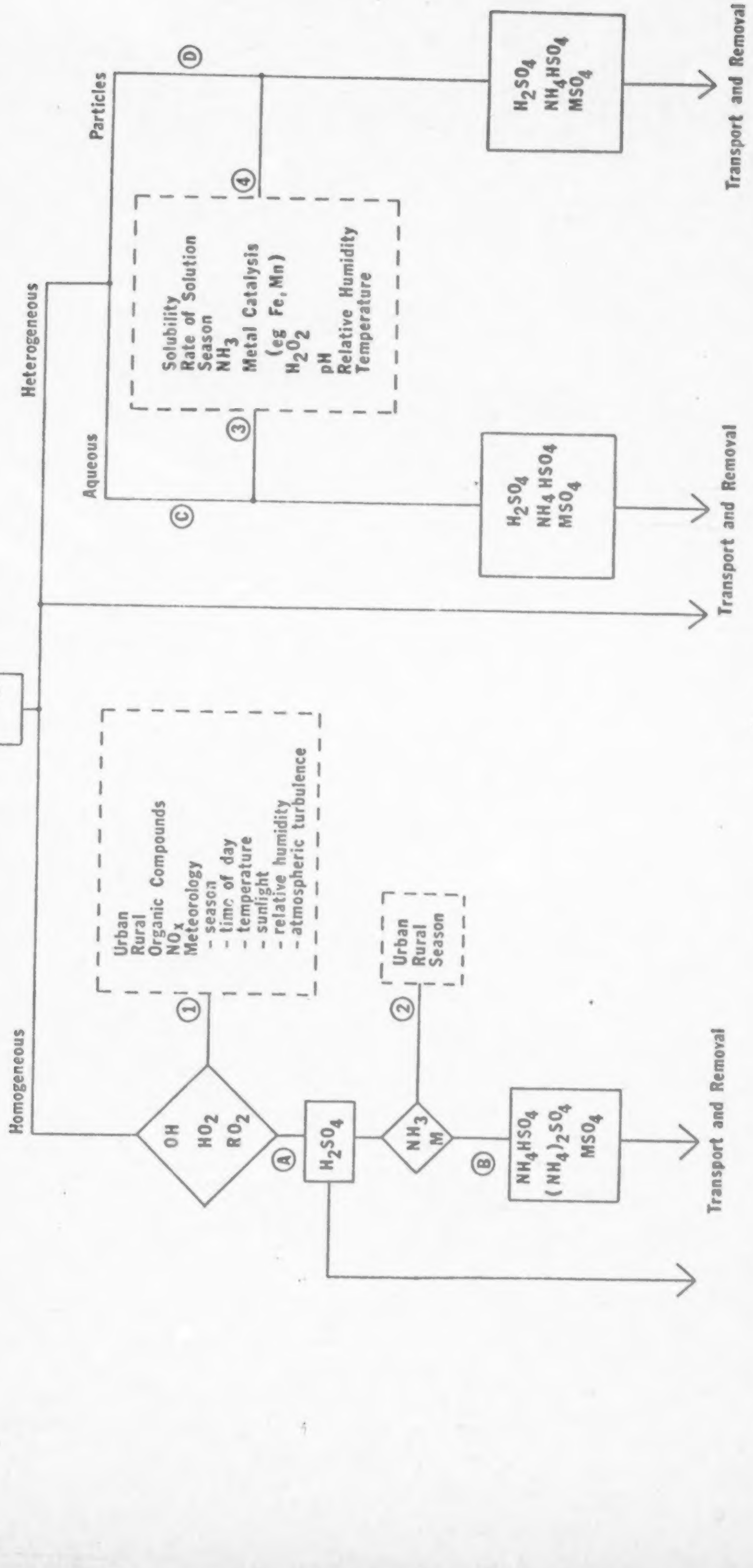

SO_2
Homogeneous
Heterogeneous
Aqueous
Particles
OH
HO_2
RO_2
①
Urban
Rural
Organic Compounds
NO_x
Meteorology
- season
- time of day
- temperature
- sunlight
- relative humidity
- atmospheric turbulence
Ⓐ
H_2SO_4
NH_3
M
②
Urban
Rural
Season
Ⓑ
NH_4HSO_4
$(NH_4)_2SO_4$
MSO_4
Transport and Removal
Ⓒ
③
Solubility
Rate of Solution
Season
NH_3
Metal Catalysis
(eg Fe, Mn)
H_2O_2
pH
Relative Humidity
Temperature
④
Ⓓ
H_2SO_4
NH_4HSO_4
MSO_4
Transport and Removal
H_2SO_4
NH_4HSO_4
MSO_4
Transport and Removal
Transport and Removal

Fig. 2 (continued)

NOTES ON ATMOSPHERIC REACTIONS OF SO_2

Reactions

A. The homogeneous atmospheric reactions of SO_2 have been thoroughly studied. The chief reaction is with OH, but oxidation by HO_2 and RO_2 also contributes. In polluted air the rate is about 1-4% hr. It is not significantly temperature sensitive.

i) Calvert, J. G., Su, F., Bottenheim, J. and Strausz, O.P., "Mechanism of the Homogeneous Oxidation of Sulfur Dioxide in the Troposphere:. Atmospheric Environment, 12, 197(1978).

Alkezweeny, A. J., "Gas to Particle Conversion in Urban Plumes:, presented at 73rd Annual Meeting of the Air Pollution Control Association, Montreal, 1980.

B. The sulphate salts are in particulate form (contrast the nitrates) A typical measurement gives approximately 30% MSO_4 (M is mainly calcium) and 70% NH_4HSO_4, which is acidic. There are also indications that biological activity will convert deposited ammonium salts to acids, with release of NH_3.

ii) Stevens, R. K., Dzubay, T. G., Shaw, R. W. Jr., McClenny, W. A. Lewis, C. W. and Wilson, W. E., "Characterisation of the Aerosol in the Great Smoky Mountains", Environ. Sci. Technol 14, 1491 (1980)

Spicer, C. W., Sverdrup, G. M. and Kuhlman, M. R., pg. 34 in Research Report to American Electric Power Service Corporation: Section C: Chemical Reactions".

C. The heterogeneous reactions of SO_2 are not as well understood. They are very dependent on prepailing conditions, and are the main cause of the variability observed in field measurements of SO_2 reaction rates. In droplets oxidation by dissolved H_2O_2 is very important, with some catalytic oxidation by atmospheric oxygen.

iii) Hoffmann, M., "Mechanism of SO_2 Oxidation", paper presented at Gordon Research Conference: Atmospheric Sciences: Air, New Hampton, June 1981.

D. Oxidation also takes place in water films on particles, and here catalysis is likely to be important.

iv) Martin, L.R., "Laboratory Studies on SO_2, NO_x Chemistry on Aerosols", paper presented at Gordon Research Conference: Atmospheric Sciences: Air, New Hampton, June 1981.

v) Spicer, C. W., Sverdrup, G. M. and Kuhlman, M. R., pgs. 28, 29 in "Research Report to American Electric Power Service Corporation: Section C: Chemical Reactions."

vi) Lee, Y-N and Schwartz, S.E., "Reaction Kinetics of Nitrogen Dioxide with liquid water at low partial pressure", J. Phys. Chem. 85, 840 (1981).

Controlling Parameters

1. Pollutants in the urban areas, e.g. NO_x, organic compounds, mean that OH, HO_2 and RO_2 concentrations (and thus the SO_2 reaction rates) will be higher there. Because these are photochemically produced, their concentrations depend on sunlight, and thus on season and time of day. Temperature appears not to be important, while relative himidity is.

J. W. Bottenheim, S. E. Braslavsky and O. P. Strausz, "Modeling Study of Seasonal Effect on Air Pollution at 60° N. Latitude", Env. Sci. & Technol. 11, 801 (1977)

2. Ammonia is a natural constituent of the atmosphere, but may be enhanced by anthropogenic emissions in urban areas. Natural sources of NH_3 will be season dependent, as will dust production.

Soderlund R. and Svensson, B. H., "The Global Nitrogen Cycle", Ecol. Bull. (Stockholm), 22, 23 (1976)

3. Aqueous phase oxidation of SO_2 will be season dependent

- gas solubility is enhanced by low temperatures
- reaction rates are enhanced by high temperatures
- emissions of metals may be larger in winter (e.g. Vanadium from combustion of oils)
- droplets are more likely to be frozen in winter

Further, the solubility of SO_2, depends on pH (and thus also on NH_3 concentrations).

4. Oxidation of SO_2 on particles actually takes place in a water film adsorbed on the particle. It is thus critically dependent on relative humidity and therefore on season. In addition the factors from 3 will all apply.

The important thing to remember if you are going to discuss chemistry in the atmosphere, is that you have to think about the location, the time of year, and the time scale that you want to look at for those reactions. Are you going to talk about a 1- or 2-day period, or are you going to talk about what happens on the average over 1 year? If you are talking about those different time periods, the understanding of the behavior is much different, and there are different conclusions you should draw.

Sometimes when people talk about atmospheric chemistry, they mix up what happens in the long term with what happens in the short term, and if one is not very careful about describing atmospheric behavior, it can sound very confusing. In reality however, there is much that is known about the atmospheric chemistry.

As an example, looking at the figure, there are three different ways that sulfur dioxide can enter the atmosphere, be transported and/or transformed, and then be removed.

The first way is in the middle of the figure. If you follow the arrow down through the middle, you see there is no chemical change in the SO_2. It enters the air, could be transported, and then removed. Certainly a lot of sulfur dioxide that is emitted can go up into the atmosphere and come down in a few hours, close to the source—if the atmospheric conditions are appropriate.

A second way sulfur dioxide can behave is to react with other gases in the atmosphere. This is the left side of the picture, and in technical jargon is known as homogeneous reaction.

What happens in this case? The general consensus on both sides of the border and certainly in Europe is that the species that are most likely to cause SO_2 reactions are compounds like hydroxyl radicals and other free radicals related to oxidants. These are formed in a variety of ways, but generally what happens is that these species promote the formation of sulfuric acid in the atmosphere. That is not always the case, but it is certainly one of the primary mechanisms.

After the acid is formed, what can happen to it? There are subsequent neutralizations that occur.

To examine another kind of reaction, look at the right side of the figure, at heterogeneous reactions. These are reactions of gases with particles or water droplets. This type of reaction can happen in storms, or in clouds, or in urban areas.

There are various things that effect these reaction rates. I have tried to illustrate some of the important factors. The area you are in (urban or rural), the time of the year, the time of the day, temperature, sunlight, humidity—all these factors play a role.

How can one understand how all these mechanisms come together? Let me try to walk you through a day in atmosphere to give you an example of how this might happen. We will look at various parts of the Eastern North American Continent on a Monday in early May. Let's say some sulfur dioxide is released in the Sudbury area from the smelter. The material could react with water vapor and other metal particles in the air, but if there wasn't too much sunlight or other chemicals in that area that day, then the transformation rate of SO_2 to acid might not be very fast—it would likely be much less than 1 percent per hour.

Meanwhile, if SO_2 was emitted the same day in another location, say, in Kentucky, the sulfur dioxide might mix in the air with urban pollutants. If it were a sunny day in that part of the continent, reactions would occur much faster—say, at 2 or 3 percent per hour. To give you an example of how heterogeneous reactions might occur, if sulfur dioxide were released in Pennsylvania, it could be sucked up in a local storm. Storms can act like violent vacuums cleaners and big mixing machines. To illustrate neutralization, if SO_2 were released in an area in Missouri, it might react with urban particles and urban gases to form acids. Then, if the acid gases entered a storm along with dust from soil, some of that acid might be neutralized. When the material comes down, one would see a lot of sulfate, but not a lot of acid. This kind of local neutralization helps to explain why sometimes one see sulfur as acid and sometimes as sulfur compounds that are not acid.

As you see from this description, the different mechanisms work in different ways in different places to transport and transform sulfur compounds. The point is that the mechanisms are there; they are known, and on an average basis, they can be expected to operate. It is reasonable to approximate this behavior and model the behavior of the atmosphere.

Since there are approximations made, one should expect the model results to be most accurate in describing long-term behavior. What people are studying is how fast some of these mechanisms are. The heterogeneous mechanisms seem to be very fast. A storm can process an immense amount of sulfur and turn it into other compounds very quickly.

Mr. CARNEY. If the sulfur oxide comes down as solids and doesn't change its form, once it is back down on the Earth, it is still subject to the same changes as in the atmosphere, is it not?

Mr. VAN VOLKENBURGH. Yes; you can have sulfur compounds come down in dry deposition, and they might sit on the surface of a leaf. Even though the concentration of the material deposited may not be high at any hour, or any day, that material can build up on the leaf, and when a rainstorm comes along, if the rain is slightly acidic already, or even if it is not acidic, the water can react on that sulfur material sitting on the leaf, and you could have an acid solution which might harm the leaf. More probably, it would not harm the leaf, but it could run down the tree or fall from the tree canopy—and then you would have wet acid deposition. You can have dry deposition coming to the ground, and a rainstorm can come along later, and all of a sudden you can get a pulse of wet deposition which is partially from the atmosphere and partially from built up dry material.

Mr. CARNEY. It somewhat complicates your ability to totally trace the compound, as to where it finally runs out, but it can and it does change after it reaches ground sometimes in its same form.

Mr. VAN VOLKENBURGH. Yes. To conclude the discussion of atmospheric chemistry: The mechanisms operate, they are there. Many are well understood, but some of the heterogeneous ones are not fully understood. There are no studies that say things are not being transformed, however. The studies are focussing on just how fast transformations can happen.

Now, turning to meteorology, I am going to talk a little bit about the role of weather, and then I would like to discuss the INCO studies because I think these are interesting. I think we in Canada know a great deal about that source and what its effects on the environment are.

What is the role of weather? We have talked about a day in May in Eastern North America. If you think of this atmosphere as a stage, you can compare pollutants to the actors and the weather to the stage director. Weather sets up the lighting, tells the actions where to move, and what roles to play.

Winds, Sun, clouds, or a storm move material about and set-up conditions for events to occur. There are a variety of ways to study how this movement and transportation occurs. One can use satellite photos, and make time-lapse movies of satellite photos which clearly demonstrate this material moving around.

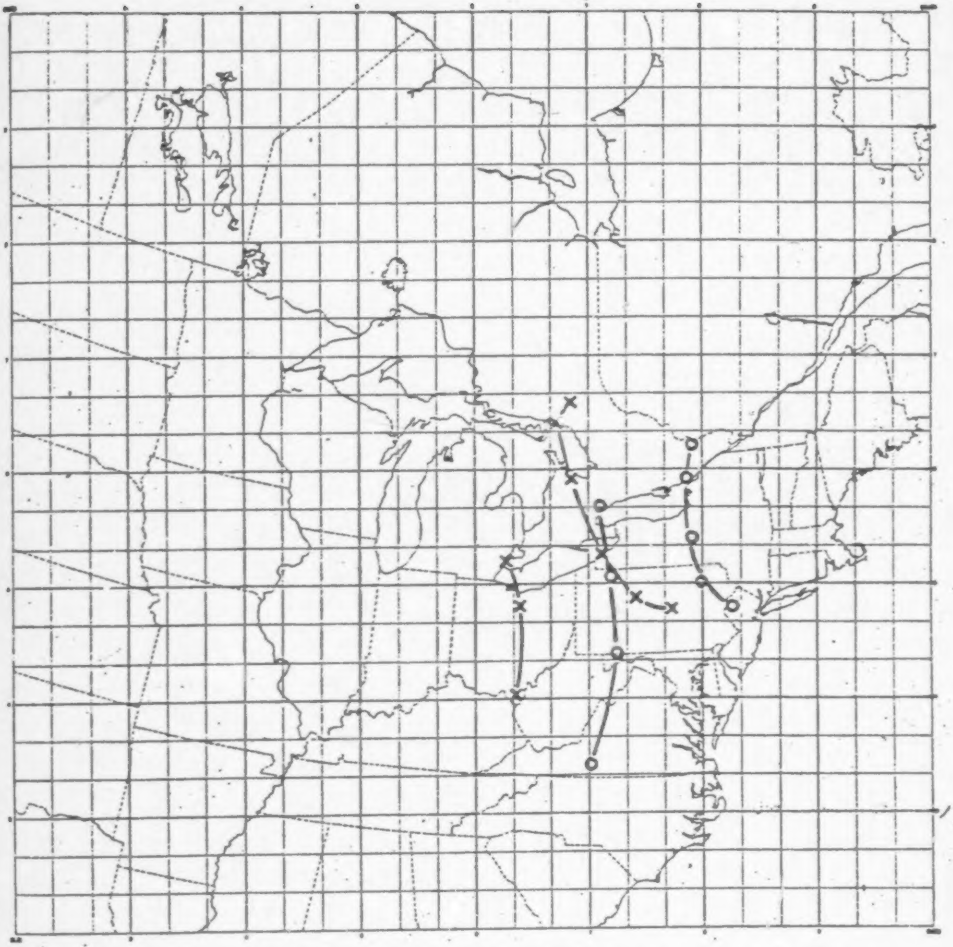
One can make ground observations of pollution levels. For example if it is hazy on certain days, this haze may be associated with certain wind directions. One can link the ground measurements of high and low concentrations in the air, or deposition from the air, with actual weather observations and get some feeling for where the air masses carrying the pollutants came from. This last method of study is called trajectory analysis. I would like to show you some sample results.

Figure 3, is an example of wind directions associated with relatively low levels of pollution in Ontario and neighboring States, on February 19. There are four lines. The first line you can see ending at Detroit, there on the left. The second line, at the top, ends at Sudbury, Ontario. The third line ends at Toronto, and the fourth at Ottawa. The ends of those lines represent where the air masses are on February 19. If you follow the lines backward, that gives you a picture of where the air came from, leading up to pollution levels associated with that day, February 19, at various measurement sites.

On that particular day, we have actual documentation from Michigan, Pennsylvania, New York, Ohio, and Ontario, of what the air pollution levels were, and they were generally low that day because in general the air masses came over areas that did not have a relatively high emissions, and the air masses did not spend a lot of time over any particular area.

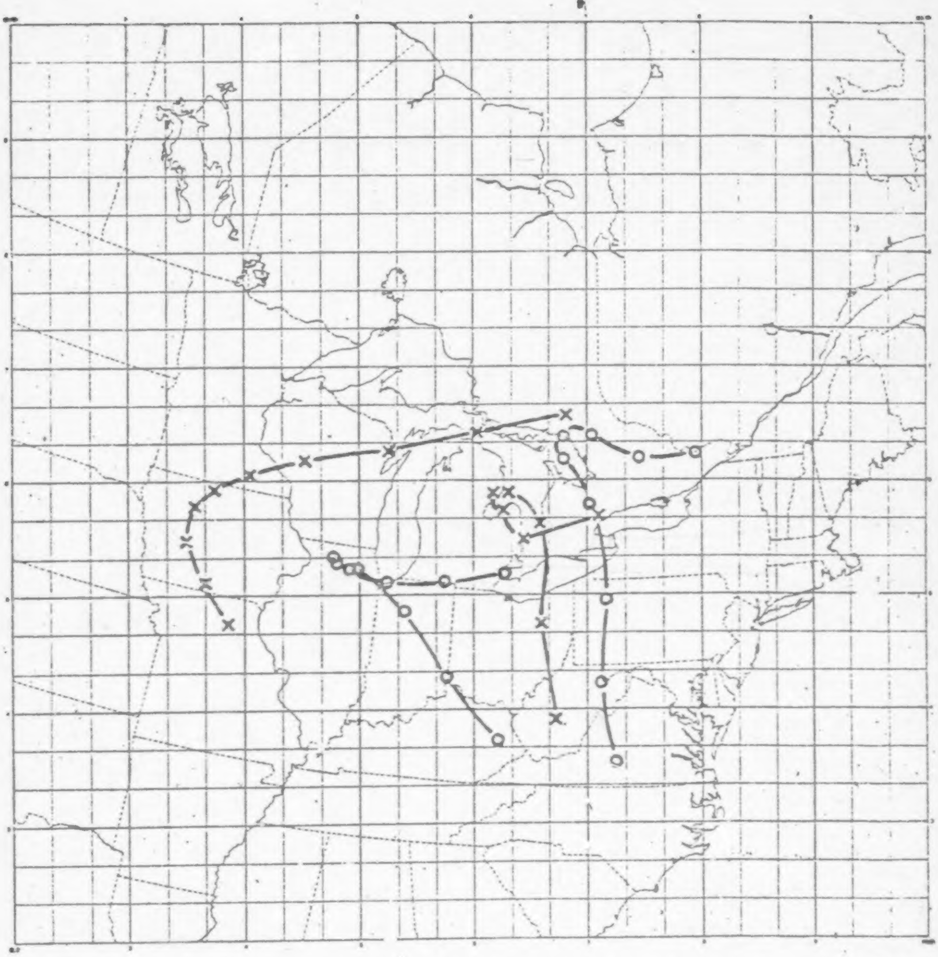
The next day, on February 20, the pollution levels went up, and they went up on a regional basis. They did not go up just in Ontario, they also rose in Michigan, Pennsylvania, and western New York. It was a regional phenomenon. That day the air had come from different places than it had on February 19, and the air masses had spent more time over areas of large emissions. Therefore the air could pick up more pollutants, and these could react and be transported with the wind. As some of the pollutants were removed from the air mass at a later time, others could be added as the air mass moved over another emissions area.

On the third day—see the handout marked figure 5—the levels dropped back down regionally. They did not drop to zero, because air pollution comes from local issues as well as from the long range, but that day, the long-range component was not that large, because the air masses had not passed over heavily industrialized regions.



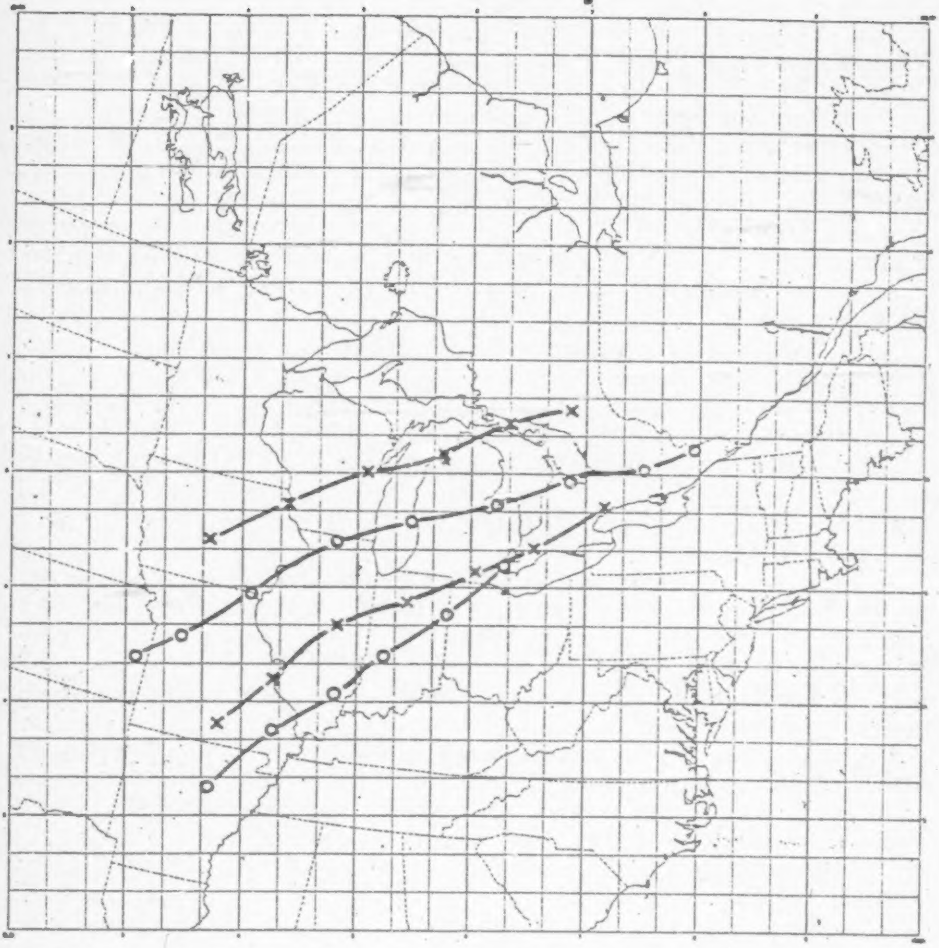
Back-trajectories showing Estimated Air Parcel locations at 6 hour intervals Terminating at 0100 EST Feb. 19/79

FIGURE 3



Back-trajectories showing Estimated Air Parcel locations at 6 hour Intervals Terminating at 0100 EST Feb. 20/79

FIGURE 4



Back-trajectories showing Estimated Air Parcel locations at 6 hour intervals Terminating at 0100 EST Feb. 21/79

FIGURE 5

We have done this kind of trajectory analysis for various areas in Canada. What kind of conclusions can we draw? First of all, the episodes of higher pollution are generally regional. In fact, they are so regional that the Province of Ontario attended a hearing in Washington on June 19, and we were able to show that our data in Ontario, New York data and Pennsylvania data showed regional phenomena. This submission is one of my exhibits.

We have also done trajectory analysis in Nova Scotia, and we conclude when the direction of the wind coming into Southern Nova Scotia is from the U.S. Atlantic seaboard or Canada—that is, the south, southwest, and westerly quadrants—we get a lot of transport. In fact, about half of the deposited acidity comes from those areas, which are far removed from the rural areas of Southern Nova Scotia.

In Ontario, the ozone incidents Mr. Bruce talked about are clearly associated with southerly winds. We do not produce ozone in Ontario. But we receive so much ozone and other oxidants from the south, that our air quality standards are violated about one-third of the time in the summer. We see consistent and widespread crop damage year after year in Southern Ontario because of imported oxidants. This part of the Province is our "breadbasket"—our agricultural heartland.

In Ontario, we have also done trajectory analysis for pollution levels in rain at Dorset, a rural resort area which is about halfway between Toronto and Sudbury. Data from this site, as well as studies we have done closer to Sudbury, are highly relevant to the effect of INCO, and I would like to focus in on the conclusions from these studies.

We have done 3 years of trajectory analysis in the Dorset area which shows that about three-quarters of the acid rain, sulphate, nitrate material, comes from the South, the Southwest, and the West. The material does not all come from the United States. Some of the material in those air masses could have been emitted from Ontario sources and some could have been emitted from U.S. sources, but there is a lot of material that comes from that direction, and most of the emissions are from the United States.

We came to the conclusion, that Sudbury must not be playing as large a role as we thought it was. Our thinking in 1976 or 1977 had been that because Sudbury is a big source of SO_2, it therefore must have a huge impact and must have the cause of our problems in Ontario.

The trajectory analysis results were hard to believe. However, we accumulated supporting information when the smelter actually shut down for 8 months, because of a strike. When we were taking measurements in the area of Sudbury, we did not see any change that was significant in these levels of deposition. Now, what does that mean? Does it mean the SO_2 has been floating around for 10 months and it keeps coming down from a saturated atmosphere, even when a source is shut off? No, it does not mean that.

What these results mean is that the deposition of the material is strongly associated with southerly flow, so that when INCO is running you see a high level of deposition, and when INCO is not running you see a slightly lower level. INCO's contribution rides on top of that high level. And there is so much change from day-today, from event-to-event in this overall level, that you cannot draw the conclusion that the average difference is really significant when INCO shuts down.

Mr. **Carney**. What parameter are you using now? Are you measuring the SO_2 content of precipitation?

Mr. **Van Volkenburgh**. Yes. What we have measured is not only acidity, but also all the sulfur in rain and snow. Sulfur dioxide can dissolve in rain. It is one of the measurements made in the rain.

Mr. **Carney**. I am not a chemist and I am not an atmospheric specialist, but this might lead me to conclude that the studies presented to us yesterday indeed are true. There is a saturation and an inability to washout material.

Mr. **Van Volkenburgh**. We once thought there might be enough material up there to cause saturation. But we did more work after the INCO shutdown and looked at an event-by-event analysis of our data. What we found was if we did this careful meteorological analysis of each event in the Sudbury area—instead of just looking at averages computed from a collection of data—we came to a different conclusion. We looked at the storms that came from the North and then the storms that come from the South.

What we saw was the northerly storms did not have as much acidity, sulfur, nitrogen, and some other materials, as the southern storms did. Indeed, when we started to classify the pollution levels according to the type of weather system, we indeed could see the effect of Sudbury. When the wind was from the North, the effect of Sudbury on acid rain in the Sudbury area was about 20 percent. You could see it. When it was from the South, it was about 10 percent, and you could see that. However, if you rolled all the data together, averaged it, and then tried to draw a conclusion, there was so much variation in each level—the level with INCO running and the level without INCO running—that you couldn't say the difference was significant. You had to go back and analyze each kind of event. So INCO certainly does have an effect. Their material is washed out locally, where the pollution concentrations in the atmosphere are strongest and one might expect to see saturation.

There is a very interesting lesson to learn here.

I would like to finish the third part of my discussion by talking about modeling. It is very interesting that our experimental studies of the INCO plume and its behavior before, during, and after the strike, agree very well with our mathematical modeling. That is significant to us because INCO is a large source; it has a high stack; and therefore it is a hard source to simulate in modeling. Yet we can simulate it well.

FIGURE 6

Annual Wet Deposition of Sulphur

Total Magnitude and Percentage Contribution of the 53 Sources

Cited by Pennsylvania and New York* in E.P.A. 126 Hearing
(Using Ontario Ministry of Environment Model for
Long Range Transport)

Sensitive Region	Total Wet Sulphur Deposition ($g/m^2/yr$)	Amount due to 53 Sources Listed	Amount due to 0.2 $g/m^2/yr$ 'Background'	Amount due to Sudbury 1979 Emissions	Amount due to Other Canadian Sources	Amount due to Other US Sources
Muskoka-Haliburton, Ontario	0.67	6.4	29.6	15.1	6.1	41.8
Algoma, Ontario	0.47	4.3	41.8	9.7	14.9	28.8
Lakehead, Ontario	0.28	2.9	70.8	1.3	4.8	19.9
Val D'or, Quebec	0.61	4.0	32.5	12.0	25.4	25.6
Adirondacks, N.Y.	0.83	8.4	23.9	4.1	5.7	56.4
West Pennsylvania	1.94	24.2	10.3	0.4	0.7	61.2

"Federal Register", Vol. 46, No. 84, May 1, 1981
"Inside EPA", Vol. 2, No. 17, April 24, 1981

OTE: Model Predictions have been verified to be accurate within a factor of 2 with 60% of estimates within 35% of expected values.

At Sudbury you can study the impact on land from the source—I am not talking about in the atmosphere now, I am talking about on land. I am sure you have been studying the plume, or the normal direction that Sudbury's plume would have and where its emissions go. Were there any changes in the ground study results—in soil content and so forth in the immediate area?

Mr. VAN VOLKENBURGH. During the strike?

Mr. CARNEY. Yes.

Mr. VAN VOLKENBURGH. Yes, we did see differences, and this was another element of very conclusive proof of the importance of long-range transport, even in an area like Sudbury. Tom Brydges staff were collecting wet deposition and bulk deposition on the lakes around the Sudbury area. We were also measuring the dry particulate. We found that sure enough, when INCO was turned off, deposition of metals that could be attributed to the plume went down by factors of 10 or factors of 100 within 50 to 100 kilometers of INCO.

Mr. CARNEY. Is that because they are heavier?

Mr. VAN VOLKENBURGH. Partially, but the observed change is also seen because there is really not a significant amount of these metals associated with long-range transport. If you start with a small amount of material coming in, and you have a much larger local contribution, so you can see a difference. But if you start with a big amount coming in, and you put the local contribution on top of the, it is like trying to subtract 99 from 100 when the level of 100 fluctuates five percent, as compared to subtracting 9 from 10 when the level of 10 fluctuates five percent. That one unit of difference can be seen with the metals, but can't be seen with the SO_2 and acidity.

Mr. CARNEY. That is why I asked you the question.

Mr. SCHEUER. Did Sudbury close down, as is frequently cited by those opposed to a more stringent degree of regulation, because of a requirement of major capital investments? As an example of a data base, it indicates an investment pumped into the system here will produce an identifiable reduction in polluting effects there. It is cited constantly; we hear the Sudbury incident as a constant drumbeat. You have apparently looked at it in more schematic, holistic fashion. What conclusions do you adduce as a result of the Sudbury experience rather that to our public policymaking? What does it indicate we ought to be doing?

Mr. VAN VOLKENBURGH. Regarding the Sudbury conclusion, the experimental studies agree with our modeling. That is important for us because it gives confidence in the modeling. The conclusion we draw from modeling and other studies is the same conclusion for Sudbury as it is for all the other sources. No one source is a villain in this piece, but each source area produces effects which can be identified and assessed in considering various emission reduction strategies.

What we are looking at is the influence from a variety of areas containing emissions. INCO is a large point source in Sudbury. The town of Sudbury can be considered as an emissions area. Sudbury is not the largest emissions source in the world, but even as one of the largest, Sudbury does not have more than a 10 to 25 percent effect on the immediate area. It has a lesser effect at long distances, but an effect nevertheless. Because of the variability of deposition, it may be difficult to see the effect, but that does not mean that it is not there.

To us that says regulation of the emissions has to proceed with all emissions areas considered, not just one. That is important. Controlling one source will not cure the problem.

Mr. REJHON. It seems to me that the lesson of Sudbury is a very simple one—to me, at any rate. When you have a serious local pollution problem and you decide to solve that local problem by building a stack which is a quarter of a mile high, you can achieve success in solving the local problem. Monitoring within a few miles or a few tenths-of-a-mile, or even a couple hundred of miles, of that stack simply proves that building a quarter-mile stack does precisely what it was designed to do, to send a lot of the stuff over the Adirondacks, for example.

Mr. Chairman, we have really taken a lot of time. I wonder at this point, inasmuch as Mr. Manson's presentation was to deal with some of the technologies, if it wouldn't be better to ask him not to make his presentation, per se, but rather to let you get on with a more general discussion. Perhaps you could ask him specific questions in terms of what is available and the costs. Would that be accepted?

Mr. SCHEUER. Surely.

Let me say this has been an absolutely facinating presentation for us, and is enormously valuable to us. We can't thank you enough for the time and effort you have put into making this presentation. It has been tremendously helpful.

Mr. CARNEY. I would like to hear some of the presentation, perhaps not in the form you had planned, on the technologies available and how do you see them as plug-ins to the overall problem.

STATEMENT OF ALEX MANSON

Mr. MANSON. Let me follow up on what George just said about tall stacks. People do sometimes look at historical emission trends and forget a very important thing, and that is that prior to about 1965 in the United States, there were essentially no tall stacks. We now have 175 of them in excess of 500 feet and a handful in excess of 800 feet, so we have all done the same thing. We have the emission trends in terms of this problem.

The other thing that I think is noteworthy in looking at emission trends is the changes in the sectors of emission. For example, in your general power industry there has been a 600-percent increase in emissions from those tall stacks, while there has not been a 600-percent increase in overall emissions. But there is a shift to places which are transporting these materials long distances.

Let me make a blunt statement about technology. It exists, it works; we know it works. The question really is, what do you want to do, because if you give us a number, we can give you the technology to achieve it.

For example, scrubbers are proven in many countries of the world to remove in excess of 90 percent of the SO_2 from the flue gases. Particularly the Japanese experience demonstrates to us when there is a commitment to the operation of these facilities, they are as reliable as the generating equipment that they are on, and you have a classic example in your own country with Louisville Gas and Electric, which has scrubbers at a higher operability than the generation units that the scrubber is on.

Louisville Gas and Electric has a very strongly committed program. It is essentially one of recognizing in the general power industry most people that work in it are mechanical engineers. Scrubbers are chemical, and you have to deal with chemical systems.

The cost of scrubbers: Perhaps the cost that I should give you is, putting a scrubber on any specific powerplant will increase the cost of electricity from that specific facility by 10 to 15 percent. The implication of that 10 to 15 percent increase on any one unit must be looked at utility-wide.

Physical coal cleaning: I believe you heard something about that yesterday. It will remove 10 to 30 percent of the sulfur from a coal-fired combustion. The reason there is high variability—is the efficiency is dependent on the characteristic of the individual coal that is being washed. There are some other benefits from coal washing in that it provides you generally with a fuel of a higher heating value and more consistent quality for people to deal with and you have transportation costs if you are transporting the fuel a long distance.

Let me move into the application of the technology since that appears to be something with which we are concerned.

A recent study was done by a consulting company in Washington called ICF, Inc., done for the Argonne National Laboratory and Environmental Protection Agency.

In this study, I noticed a 7-million emission reduction was achieved in the eastern part of the United States over the next decade. That is one of the options they looked at. This kind of a program would result in additional revenue requirements for the utilities in the area of approximately $2.5 billion a year by the end of the decade. However, a very interesting fact in it: It would result in an average utility rate increase of less than 1.5 percent in eastern utility rates.

That is not to say that in some specific areas there would not be higher increases where there was a greater proportion of the emission reduction taking place. In States such as Ohio the utility increase would be approximately 5 percent. However, I think I must add that in looking at the States which would bear the majority of the cost in a program like this, they are also the ones who have the lowest utility rates to start with, so you are going to the places where the rates are lowest in terms of adding this increment on the top of it.

George mentioned that the emission sources in our two countries are very different, and I can't emphasize that enough. The bottom line is identical actions on sources are not going to work.

I would like to talk briefly about some of the things that have been done in Canada in the recent past, the application of technologies. I must emphasize these things were done in specific response to the acid rain problem. The Province of Ontario issued a regulation to the INCO smelter in Sudbury that limits SO_2 emissions right now to 2,500 tons a day.

There is a requirement that by 1983 they be reduced a further 25 percent to 1,950 tons a day. There is a Federal Provincial Task Force in place right now working diligently, which is to determine the lowest emission rate which is technically and economically feasible. The report of the task force will provide a basis for further reductions in emissions, and I am sure if you have been listening to speeches by the Federal Minister and the Provincial Minister of the Environment, you have heard that commitment stated very explicitly.

Mr. SENSENBRENNER. How much SO_2 was emitted in Sudbury prior to the order?

Mr. MANSON. We can go back to 1969, when emissions were 7,000 tons a day. It is essentially 70 percent contained at the moment.

Mr. SCHEUER. Dr. Manson, I have been turning over in my mind your remarks to the effect that the enormous expenditure—I don't know what percentage of the $2½ billion annually would be imposed on the Ohio River Basin polluters, but I am struck by your remark that their rate base would only go up 5 percent. Is part of the explanation for why that figure is so small, the fact that this investment in scrubbers has added to the economies of operation, and that that has taken care of a good bit of the additional investment; that the investment has resulted in an operating efficiency and therefore the rate base increase has only been 5 percent?

Mr. MANSON. The reason it is only 5 percent essentially is when you can fault an individual facility like a powerplant—your utility bill is based on what it costs that whole utility to generate its electricity. He doesn't know whether it is shifting electrons from powerplant A, B, C, or D; so it smears the increase from one facility across the entire generation base.

The Province of Ontario has also issued a regulation to Ontario Hydro, which is the public utility which supplies electricity to the residents of Ontario—to reduce its total SO_2 emission across the entire generation system to 260,000 tons a year by 1989, and this is about a 43-percent reduction.

Mr. SENSENBRENNER. Doctor, I have a ranking of the top 50 coal-fired powerplants in Eastern North America, put together by the Ontario Department of Environment. The No. 1 rank is the Paradise plant in Kentucky, which emits about 372,500 metric tons per year according to your study. That is only 15 days of Sudbury, even after the reduction that has been ordered by the provincial government in Ontario.

Mr. VAN VOLKENBURGH. As a person on the Ontario committee, one of the things I carry around with me are emissions in various forms. My understanding is right now, 2,500 tons per day at Sudbury will be on the order of 900,000 tons, depending on what unit you are using, metric or short—that is short.

Now, when we get down to 1,950 tons per day, which will be 1983, we are going to be looking at on the order of 650,000 to 700,000 tons a year.

Mr. CARNEY. What are you at now?

Mr. VAN VOLKENBURGH. 2,500 tons a day, which would be 900,000 tons a year. We cannot operate above that level. We have tied up a large capacity of INCO.

Mr. CARNEY. How do you do it?

Mr. Van Volkenburgh. We told them to do it.

Mr. Carney. Did they just stop smelting?

Mr. Van Volkenburgh. Yes. Not completely. Now, from 7,000 down to 3,600 tons a day, they put in sulfur rejection at the front end of their process. To get from 3,600 to 2,500 tons a day they had to reduce their operation capacity.

Mr. Carney. They were right at 7,000 tons per day, and they reduced it in half by——

Mr. Van Volkenburgh. Various schemes of rejecting the sulfur in the ore prior to smelting. They put in some acid plants in the process as well.

Mr. Carney. Then they went from 3,600 to 2,500; is that correct?

Mr. Van Volkenburgh. Yes.

Mr. Carney. And they did that mostly by reduction of production?

Mr. Van Volkenburgh. That is right.

Mr. Carney. What do they intend to do to get on down to 1,950?

Mr. Van Volkenburgh. There is a new rejection process they are putting in that is analogous to washing the ore. That will be a new process where they will grind up the rock and with washing techniques take a lot more of the sulfur out.

There are two kinds of ore. One has the nickel, one has a lot of sulfur. They can mechanically separate up to a point, but to go below 1,950 tons per day, they are going to have to actually change their smelting process, and this is why we have the Federal Provincial Task Force.

Mr. Carney. May I ask what might be a naive question: Could they accomplish their goal by using stack scrubbers?

Mr. Rejhon. No, you can't do that. It is a totally different series of technologies. In a metal ore, you have essentially the nickel atom combined with the sulfur atom and to separate them you have to heat them and in the process of heating the sulfur combines with oxygen and up it goes. That cannot be dealt with effectively by scrubbers. It needs a different process.

Mr. Carney. Sulfur oxide is what is coming out of our powerplants. If we could take sulfur oxide coming out of our powerplants with a scrubber, why can't you take sulfur oxide coming out of your powerplants with a scrubber? The scrubber is on the end of the process.

Mr. Manson. It is a simple explanation. The waste streams coming off of the smelting process have too low a concentration of SO_2 to run a scrubber. We are looking at a new process which will provide a much more concentrated stream to be treated to make acid. The old process technology is untreatable.

Mr. Scheuer. As you get more successful in eliminating the SO_2, it gets more difficult to make further progress, and you have to apply higher technology at great cost.

Mr. Manson. INCO has dealt with the front end of the process and the back end. We are now in the middle of the process trying to make changes there that will affect further reductions.

Mr. Carney. May I ask a question of Dr. Volkenburgh?

Yesterday, Dr. Mohnen gave testimony, and he stated that the lower Great Lakes region was saturated with SO_2 and proposed a new concept to us of what he called a superbowl of pollution in which it is impossible to relate the deposition of a source. I wonder if you would care to comment on that?

Mr. **Van Volkenburgh**. I think the Sudbury shutdown experience is extremely relevant. The loadings of sulfur and acid compounds coming out of the atmosphere in the Sudbury area are among the highest in the world. We are almost right in the middle of this high pH and sulfur loading piece of wet deposition that Mr. Bruce showed at the beginning of the hearing.

I think that is one indication that perhaps the atmosphere is not saturated. I think a second thing to consider is that there are a lot of storms that can process huge amounts of material. Thunderstorms, for instance, are literally vacuum cleaners.

A third thing that has to be remembered about the Doctor's testimony, there was a remark that I had in my talk that indicated, when you look at chemistry in North America on a given day, and you averaged it, you have a lot of information you have to consider. It is like the old story of three blind men tring to describe an elephant, and they are sent into a room with the elephant; one feels the trunk, one the leg, one the ear. Unless you put all three—if you put all that information together, you will get a good description of what goes on.

It is our understanding of Dr. Mohnen's hypothesis, the hypothesis is based on two monitoring sites out of many monitoring sites operating in North America, and I think his feeling is that the western monitoring site, the one in Illinois, is a background site, and he sees a lot of material coming from the Southwest, but in point of fact there is over 650,000 tons of sulfur a year emitted within 150 miles of that site. In fact, it is emitted upwind of the site, in the direction where he says he is getting a lot of deposition. So I am not sure his thesis should not be reviewed and reviewed very carefully, just as our data is reviewed.

Mr. **Scheuer**. It is now a couple minutes after 12, and we have to adjourn at 12:10. I think we would like to hear from the Canadian parliamentarians, and if any of my colleagues want to make remarks, we will be happy to hear from them, and then I think we will have to close.

This has been an enormously valuable session to us.

Mr. **Rejhon**. I would like to make a couple of closing comments.

First of all, what we have tried to do in setting out for you the underpinnings of our concern about acid rain is stay carefully within the bounds of what we believe is scientifically sound and analytically valid. We think this is essential. We believe our case is strong, that the evidence as agreed upon by the vast majority of scientists who have dealt with this issue is persuasive. It is substantial, it is convincing, and it is worrying. In a society such as ours, you can predict with absolute certainty the data base will never be complete and that scientists will always disagree about parts of it.

From your point of view as policymakers, it seems to me you have to look at the preponderance of evidence, such as comes from your National Academy of Sciences, which is overwhelming. You have to look at the distribution of the scientists who argue and how they argue in terms of where they come from and what they are saying and what are their relative numbers. If you do that, you will find the vast majority of independent scientists basically agree with the kinds of things we have been saying today.

Finally, you have to consider that a good scientist demands a very high degree of precision—quite properly—before he will embrace a hypothesis and until he sees that high degree, he is quite right in holding back and saying, "I am not prepared to make a decision." The public policymaker does not have that luxury. If the public policymaker says, "The scientist has not attained that high degree of certainty; therefore, I will not make a decision," that is not true. The public policymaker has indeed made a decision. He has made a decision not to act. That is a fundamental danger in moving from the world of science to the world of policymaking. You have to decide when you have enough evidence to take at least a first cut at some rational, sensible policy decisions.

Thank you, Mr. Chairman.

Mr. **Scheuer**. I think that is a marvelous closing note, and I want to thank you all. We are in total unanimity that this has been a tremendously productive session, and we are grateful to all of you.

Now, may I turn the floor over to Mr. Fraser?

Mr. **Fraser**. We have but a few minutes. I wonder if I could ask each of my colleagues to make a brief closing statement, and we will commence with our senior colleague here, Ian Watson, who knows how to make a long speech, but I am sure knows how to make a short one, too.

Mr. **Watson**. I am sure we are all convinced here this morning that there is no longer any doubt about damage to lakes and fish. As a layman, I can't believe that with acidic precipitation levels constantly in our region between 10 and 40 times normal, that there is not also an effect being produced on human health and on forest growth.

I think we ought to accept the degree of research is where the research was on fish and lakes 8 or 10 years ago. Hopefully within another year or two we will have the kind of proof regarding forest growth and human health that we have had this morning with regard to fish health and lake health.

Two years ago, it was predicted that emissions from the thermal power generation industry in the United States would result in about a 14- to 28-percent increase in sulfur dioxide emissions. I don't know whether any of you gentlemen have seen this article that appeared in Barron's the other day, which is entitled "Nuclear Fizzle," but this article indicates very clearly that the likelihood in the States is now that coal-powered generation will be moving ahead even more quickly than was anticipated even 2 years ago.

The National Academy of Sciences a couple of years ago came out with a study—I can't pinpoint it, but at the time—the notes I made were, a single coal-fired plant over its lifetime would cause indirectly 25 fatalities and 60,000 cases of respiratory illness.

I think it is going to come as a terrible shock——

Mr. **Scheuer**. Per what?

Mr. **Watson**. Over the lifetime. I am afraid the note I made is a very nonscientific one, but it does refer to a National Academy of Sciences study that appeared a couple years ago.

It will come as a shock, I am afraid, to the antinukes that their successful program to slow down or stop the U.S. nuclear industry will probably have the effect of doing far more damage to human health, far more damage than was ever possible under an expanded nuclear program.

There are several things that are being proposed in Washington right now upon which I would like to comment. The transfer of regulatory power which is being proposed from Washington to the States is not our business, providing it doesn't result in a worse effect for us in Canada. It is not our business.

For example, if you people decide to use more—change the regulations to use more low sulfur-western coal instead of eastern coal, that is a political problem for you, but that is really not our affair if it can produce an end result that is good. If a relaxation of your regulations allows this, then I certainly, as an individual, would have no objection to that, but it is the end result as far as Canada that is going to count.

I wonder, though, in this proposal to turn over authority to the States whether the States fully appreciate what they are in for in accepting this new responsibility because they are certainly going to be accepting, I would think, legal liability as well with the turnover of these regulatory powers. I am wondering whether it wouldn't be a good tactic for you people to be alerting individual States to the danger of them accepting this new power that Washington wants to transfer to them.

Now, in practical political terms, we are all asking ourselves—you are asking yourselves particularly—what you can do to convince the Reagan administration to not pull back and to move ahead in dealing with this problem. The principal political constituency of the Republican Party is the middle-class, the upper-middle-class, and this is the group, it seems to me, that is much more likely to be concerned about fishing, lakes, sport fishing, and environment generally than even the Democratic constituents, so I think there is a hope there that if a strong case can be made, that the political impact will filter through to the administration.

Of course, once public health concerns can be proven, I think there will be a massive outcry and that this will produce an effect, and once it becomes clear that forests are being affected in an economic way, then I think we can count on the forest industry to start using its lobbying club in Washington to put pressure on the administration. But this is maybe a year or two down the road and what we need is action faster even than that if possible.

Presumably your advice to us, gentlemen, is that we continue to make the case for corrective action as forcefully as we can, but without abrasiveness if we can avoid it, but I can tell you that public sentiment in Canada is going to become increasingly angry as evidence of this damage spreads.

Mr. **Scheuer**. It is the same anger that was reflected in yesterday afternoon's hearing from the Adirondack community.

Mr. **Watson**. And we are going to be calling upon you to live up to the spirit of the bilateral agreements we have with you. If this doesn't work, we will be turning to the international community. I think it is worthwhile reminding people here—I don't think it has been mentioned so far—that the Helsinki accords required that one

State's activity should not degrade the environment of another State.

Now, the Helsinki accords have been, we all agree, tremendously advantageous to the West, the United States, in particular, in the world battle for men's minds, and I think you should reflect upon the possibility that whether there will be the same advantage coming out of these accords for the United States if Canada at some point feels obliged to raise the acid rain problem in the context of those accords.

I guess really that is the end of what I have to say, but I just think these are two or three points I would like to get your reaction to as to whether they are methods of administering the pressure I think we all feel is necessary on the administration to move in the direction we want.

Mr. **FRASER**. Thank you very much.

Mr. Blackburn?

Mr. **BLACKBURN**. Thank you very much, Mr. Chairman. I will be as brief as possible.

As far as I am concerned with respect to acid rain, we have demonstrated before us today, and as far as the Subcommittee on Acid Rain in Canada is concerned throughout the past year, there is ample hard scientific data available at the present time on which to base political action.

Second, we have available to us the technology in order to reduce and in some cases totally eliminate acid precipitation. So my third point follows from the other two, what seems to be lacking, but what is extremely necessary at this time, is the political will.

When I say lacking, I am not referring to anybody in this room today. I am referring to some elements in Canada and I am referring to elements in the United States, to which there has already been made reference by both Canadians and Americans here today.

But the political will, will not materialize into action, in my opinion, unless we adopt a moral and ethical approach to the problem, or at least put as much emphasis on the moral and ethical aspects of this problem as we will be forced to place on the economics.

If we simply talk about cost benefit, how can we possibly weigh the benefits of going fishing, or hunting, or living in a clean, fresh atmosphere and environment, with the dollars it is going to take today or tomorrow to clean up that atmosphere so that in 10 years' time we do have a healthy environment in which to live, work, and play.

Let us not get too hung up simply on the economics. It is vital, it is important in a political argument in Washington and in Ottawa.

Let us resolve that from a moral and ethical point of view we are going to, as legislators in both countries, assume the responsibility for passing on to our children, our grandchildren and successive generations, a country—in this case a continent—blessed with tremendous natural resources, tremendous beauty, fresh water, clean air, which we inherited.

We cannot fail successive generations unless we reverse the pollution process and pass on to them an environment that our grandfathers passed on to us. This sounds very flowery, perhaps, but unless we get a handle on this from an ethical and moral point of view, I don't think we can proceed with the economics. I don't think we can proceed with the policy. We are going to run up against industry, against politics, and statesmen, whether they be in the United States or Canada, who will always throw at us the economic block, who will also throw at us practical problems.

I doubt very much whether 10 years ago, we would have got the water quality treaty with respect to the Great Lakes in place if there had not been an oral commitment to do so. If we had sat back and said, "Look, there are too many economic problems, it is going to cost too much, there are too many political obstacles," you could probably walk across Lake Erie today. Instead of this, the bass fishing has come back, and the tourist dollars are coming back as well.

So let's look at the morals and ethics of this, as we pass on what was once a beautiful part of the world and will once again become a beautiful part of the world in which to live if we assume our political and our moral obligations as well.

Thank you very much.

Mr. SCHEUER. Derek, I only wish you had made that statement from the well of the House. I wish every Member of the House and Senate could have heard your remarks.

Mr. FRASER. Mr. Chairman, in summing up, I will be very brief. There are just a couple of things I want to stress, both to our colleagues in Congress and also to all of you ladies and gentlemen who have been here.

The first thing I think we have to understand is that we could change the Federal Government of Canada tomorrow and the determination to continue the cleanup of acid rain would not change. That applies equally to provincial governments. I can say this with the full support of both my colleagues: there is no political difference on this issue in Canada.

The second thing I want to say is this: Canadian politicians have got to be seen getting somewhere on this, in relation to our discussions with you. To the degree we can succeed, that is going to be useful and helpful in the continuing relationships which we must have with each other, because we share this continent.

Now, I don't want to underestimate the seriousness of this, because if we can't be seen to be getting anywhere, the pressure in Canada is going to increase to the point where it will explode. That will affect our relations as two countries, and that is going to mean that everything we discuss at this table will be linked to acid rain. That is a debilitating thing in terms of international relations and not to be desired at all. I must be blunt, and I must say that is exactly what is going to happen if we can't get anywhere.

The other thing I want to say is this: You have, to some degree, to fight our battle for us. We ask you to do it because we are your friends. We are prepared to fight your battle and clean up our side of it as well. But there are several accusations that are being made against those of us both in your country and our country who want to clean up.

One is that there is some kind of Canadian conspiracy to either promote nuclear, or to get our people's problems off—peoples minds off our present domestic problems, or to use the acid rain situation in some kind of context with some of our policies which your Congress doesn't like very much.

Now, let me just meet those head-on. First of all, the acid rain situation was raised on a national level in Canada 2 years ago by myself as a member of a Conservative Cabinet of that Government. It was done by a Conservative Government which was openly pro-American. It was done by a Conservative Government that for the first time in many years in Canada came out loud and clear, determined to assist the United States in terms of our military obligations in NATO, in terms of finding ways to help your cause in the international world. I was in the cabinet that made the decision, and it was a risky one, to remove your hostages from Iran. I am not saying that we should get a hero's medal for that, because I think you would have done the same thing if the situation was reversed.

We were also the Government that came out and said in view of Afghanistan, we support your boycott of the Olympics and also cut back our grain shipments. I can say that as a Conservative.

I am now in the opposition. But I want to stress the fact this acid rain thing was raised by a Conservative administration and it wasn't raised for any of the reasons that some of our enemies are saying.

The last thing I want to say is this: On behalf of all of us you have been very hospitable, and you have given us a really first-class hearing. I want to thank the members of our Canadian team, because if I say so myself, I think they made a first-class presentation.

Mr. Chairman, colleagues, ladies and gentlemen, you are our friends. We happen to know you are the best friends we have. We want to stay your best friends. We share this continent, and we have got a moral obligation to make sure that our children and our grandchildren share it as friends and share it with the duties and the opportunities that can be made available to all of us.

Thank you very much.

Mr. **SCHEUER**. I want to thank all three of you for your flattering remarks. We are all deeply moved. The tragedy is, you are speaking to the choir here. You are speaking to the converted.

Mr. **FRASER**. But it is on the record.

Mr. **SCHEUER**. That is right, and we have the 225 million Americans to reach and whose level of consciousness we have to stimulate.

I would like to ask the ranking minority member, Congressman Carney of New York, if he wants to say a few words and finally recognize our host colleague, Dave Martin.

Mr. **CARNEY**. Thank you very much, Mr. Chairman. I, too, would like to thank our colleagues in Canada, both the Parliamentarians and their experts who have taken time from their busy schedules to come down to lovely Lake Placid to help us make our presentation to the members of our government bodies.

We have to realize when we sit at a table like we are doing today, we are doing something right. Let us continue sitting at these tables. Certainly we will not be in agreement on all the issues. The art of politics is one of give-and-take and compromise, and I think we can see that coming.

I see personally in my own judgment an enormous improvement in the relationships between the United States and Canada, and I don't think acid rain is going to get in its way. I think we are going to deal with that problem.

I would only hope—I think everyone realizes it is only for the betterment of everyone on this most beautiful continent we live on.

I would like to buy up one thing one of our Canadian friends mentioned: Pay me now or pay me later.

It is a significant thing that we can use in clearing up this situation. We know what are the costs to clean up the air now, and we have a pretty good idea of what the cost will be if we don't do it now.

There is a very interesting commercial that plays in our neck of the woods, and I am not sure it plays up there. An oil-filter commercial, where the man comes on television and says, "You can pay me four bucks now to change the oil filter, or you can pay me later when I put a new engine in your car."

That is a very significant point, and I think it is a very significant point we can use in this argument.

It is my understanding we will have the opportunity to come up to your great nation and thoroughly investigate your scientific resources that deal with this problem. I personally look forward to that opportunity, so I can react with greater knowledge when I have to make critical decisions in our Government body.

I know that the gentlemen to our right over here have the same problems that we do. We can either say yes or no on an issue. We can't say maybe; we can't say tomorrow. When it comes time to fish or cut bait, we have to say yes or no. We have to make hard decisions. The sooner we make them, the better off we will be.

Again, thank you very much for your participation in this most productive meeting.

I turn the microphone over to my colleague Congressman Mitchell.

Mr. MITCHELL. I would like to compliment my Canadian colleagues. We sat through a frustrating 2 or 3 hours yesterday listening to American scientists telling us the only thing they could agree on is that we should not do much of anything. At least they didn't give us any indication that we should act.

I just want to also state that I hope you don't become too discouraged if we don't act as rapidly as you feel we should. The people here I know are deeply concerned with acid rain, but we have a lot of colleagues who haven't heard of it.

I just want to highlight a few of the problems we are going to have in fighting the problems. We are probably 2 years behind you in public awareness. We tend to solve problems in America. When our media gets behind a problem and tells the people there is one, then the people tell their elected officials they would like to do something about it. In America, we haven't the widespread problem you do. We are concerned about 3,000 lakes, and you are concerned about a million in Canada.

Also, the industries that are impacted in Canada, lumbering, fisheries and tourism are bigger industries affected by acid rain than in America. So the dollar value which does sometimes control is more significant—its impact on your economy than on ours.

We also seem to have a problem in America getting a clear scientific consensus. At the present time, our scientists are arguing about what the situation actually is.

Finally, as our good chairman mentioned, we have an anti-regulatory momentum building in America. The President is very popular; he campaigned on a slogan he was going to get Government off our backs and out of our pockets, and in many cases that is a really fine thing to do. We have regulated ourselves excessively in many areas. We can't compete with foreign industries because we are overregulated. But in this particular instance I think the administration is not correct, and I am certainly not going to go along with any effort to lessen our clean air standards.

Finally, we have awesome budgetary problems this year. We just cut $42 billion. An awful lot of people were getting Government funds. Dollars are very short. Now they are talking about cutting another $100 billion over the next 3 years.

So it is going to be very, very hard to get funding, and people are going to evaluate whether it is better to combat the acid rain situation or whether it is better to build more nuclear carriers.

I guess you couldn't quite build a nuclear carrier for what it would take to solve the acid rain problem. That is the point. We are trying to balance our budget; we have a high inflationary rate; our interest rates are 20 percent and people are screaming to get those down, and you can't get them down unless we spend fewer Government dollars.

I don't want to sound too discouraging. I just want you to know the dimensions of our problem. I am going to do what I can to resolve it, but we probably won't be able to act as rapidly as you would like us to, or I would like us to, because of these other factors.

Mr. MARTIN. My comments will be very, very brief, indeed, in that our chairman is hosting a cocktail reception at 12:30 at the Bergermeister, across the street, for our Canadian friends and those who have come from Washington.

As perhaps the only Congressman in the United States that has to get permission from the Speaker of the House to make an international flight to get to Washington—that is, when I leave Ottawa—I feel very much at home here, not only being in my home district, but with some friends that I have made since I have been in Congress, such as Ian and his colleagues, as part of the Canadian-United States Inter-Parliamentarian Group, where we have an opportunity to meet and discuss not only this issue but many issues which vitally affect the issues of our great Nations. I have the philosophy we can do virtually anything when everybody works in the same direction. I think this is one of the cases where we are ultimately going to be successful in resolving the problem, hopefully to everyone's satisfaction.

With that, I have the distinction of being able to close this meeting, but, before doing so, it is only appropriate I salute our outstanding chairman, Jim Scheuer, and our ranking Republican member, Bill Carney, who have worked so hard on this and who have shown me so many courtesies.

Believe me, I appreciate it.

With that, I will conclude the meeting.

[Whereupon, at 12:33 p.m., the subcommittee adjourned, to reconvene subject to the call of the Chair.]

ACID RAIN

THURSDAY, NOVEMBER 19, 1981

House of Representatives,
Committee on Science and Technology,
Subcommittee on Natural Resources,
Agriculture Research and Environment,
Washington, D.C.

The subcommittee met at 9:20 a.m., in room 2318, Rayburn House Office Building; Hon. James H. Scheuer (chairman of the subcommittee) presiding.

Present: Representatives Carney, Sensenbrenner, and Schneider.

Also present: Representatives Shamansky, Gregg, Edgar, and Mitchell (New York).

Staff present: Dr. Robert Palmer, Maryanne Bach.

Mr. **Scheuer**. The Subcommittee on Natural Resources, Agriculture Research and Environment will come to order. Today we are going to have quite an unusual hearing, in which we will hear from eight distinguished witnesses from all over the country on the state of research on the subject of acid rain; on what the current knowledge base permits us to do on a cost-effective basis in controlling pollutants of all kinds; on what additions to the current data base we need over the next 2, 3, 4, 5 years to make a further incremental level of enforcement cost effective and sensible; and on the kind of research that ought to be done in the short, medium, and long run, as we make thoughtful, intelligent, incremental efforts to approach a relatively pollution-free environment.

As all of you know, the subject of acid rain is an agonizing one. There are deeply felt, emotionally held commitments and expressions on the two ends of the spectrum. Many feel that more research has to be done before any capital investment in new equipment or pollution control technology is sensible on the part of industry, before we—the Congress—impose massive capital costs on industry. On the other end of the spectrum there are those who feel we ought to be approaching a zero pollution environment now, and that almost an infinity of controls, perfect pollution controls, should be imposed on industry.

We are trying to find out for the benefit of the entire Congress, as we approach marking up of the Clean Air Act next year, what a rational, centrist, reasonable, cost-effective posture would be for this Congress, considering the urgent need to stop this degradation of our environment—our waters, our streams, our lakes, our fish, our forest products, our agricultural products—and the environment of other nations. What are reasonable incremental levels of environmental controls, that would be sensible on a cost-effective basis, considering the needs of the environment and considering the needs of our industry to become more efficient and more productive, considering the need of our country to compete successfully in global markets?

It's perfectly apparent that we don't want to engage in silliness and impose billions of dollars of costs annually on our manufacturing industries, on our utilities, on our moving energy sources, if the results aren't clearly worth the costs involved. And we are looking to these eight experts, who are here to advise us in the Congress as to what level of controls is sensible now, and what is the type of research that ought to be done over the near future and the long-term future, to justify success of incremental levels of additional controls.

Acid rain is not only polluting our environment; it's polluting our international relations. I have been to Canada several times, conferring with our Canadian colleagues. We had a very interesting hearing in Lake Placid on September 19 on the subject of acid rain in which a number of Canadian Members of Parliament as well as ministerial officials in environmental agencies testified and expressed their deep concern. I heard by telephone yesterday afternoon from the Canadian Ambassador in Washington, who reiterated his concern for the devastating problems of acid rain on the Canadian economy. He is deeply grateful for the work this Congress is doing, for the work this committee is doing, and we know that our work is critically important to our Congress, our people, and our neighbors to the north, and we're deeply grateful for the effort that you gentlemen have put in.

I might say for the benefit of my colleagues up here that these experts spent all day yesterday brainstorming the question of acid rain, brainstorming the question of what we should do now in the field of pollution-control technology, what should we mandate upon industry that is supported by the current data base, and what kind of research we should be looking forward to. So we are very grateful to all of you.

After I introduce my colleagues, I will turn the floor over to Bob Trumbule of the Congressional Research Service, who is going to give a thumbnail summary of what went on yesterday. And then we will be hearing briefly from each of the witnesses, and then we hope to get some cross fertilization between the witnesses, and the members, and the witnesses.

So, without further ado, let me yield to the ranking minority member of this subcommittee, Congressman Bill Carney, my New York State colleague, who has been a very creative, contributing member of this committee and whose work we all value very much.

Mr. CARNEY. Thank you very much, Mr. Chairman. I think it would be prudent of me to be very brief. We do have eight distinguished witnesses that will be giving us testimony, so I will simply do this: I will welcome you all on behalf of the minority. I will apologize for not having had the opportunity to meet with some of you last night as was planned, but our legislative duties would not allow us to leave here before 9:30 last evening. I will also note that, unfortunately, as it often happens, we have conflicts with scheduling. We might have to leave for a markup in our Oceanography Committee, which would mean we will be coming in and out. If that should happen on a change of a speaker, don't take that personally.

I again thank you all for helping and participating in this very important hearing.

Mr. Chairman?

Mr. **Scheuer**. Thank you. Congresswoman Schneider?

Mrs. **Schneider**. I have no comment at this time, Mr. Chairman.

Mr. **Scheuer**. All right. Congressman Edgar?

Mr. **Edgar**. Thank you, Mr. Chairman. I will be very brief. I happen to represent a small district in suburban Philadelphia. I am chairman of a group called the Northeast-Midwest Congressional Coalition that has not only the Midwestern section of the country, but also the Northeastern section of the country, and our coalition has been very interested in the role that we can play in educating people to the impact of acid rain on our States as well as some of the producing States. I look forward to not only listening to the testimony, but using some of that in our coalition to do some additional education.

I think the issue of acid rain is so important that this briefing will be helpful not only to Members of Congress in both Houses, but also to continuing discussions over the years. I would just like to thank all of you for taking the time to come.

Mr. **Scheuer**. Congressman Don Mitchell of New York, who represents the Adirondack region and who played a key role in our hearings in the Adirondacks about 6 weeks ago. Congressman Mitchell?

Mr. **Mitchell**. Thank you, Mr. Chairman. I am mostly concerned with some action that we can take to counter the destruction of the ecology of the Adirondack region—I represent a considerable portion of it; I am disappointed with the mixed signals we are getting from the scientific community in our hearings at Lake Placid. I think the bottom line as far as our scientists are concerned is that we shouldn't do anything because there isn't enough research.

I realize we should be certain before we proceed, but I would like to know from this panel, what do we agree on? Is there anything we agree on in this area? What relatively inexpensive steps can we start tomorrow, before we have reached the bottom line of our scientific analysis? And how can we expedite the research toward reaching a final solution? Those would be my concerns.

I want to thank you all for coming. I apologize that we got such a late start.

Mr. **Scheuer**. Congressman Judd Gregg?

Mr. **Gregg**. I would just like to congratulate the chairman, and the ranking member for holding these hearings. I certainly appreciate their proceeding so promptly on our bill. And I thank this tremendous panel for appearing today, and look forward to hearing what they have to say.

Mr. **Scheuer**. Thank you very much, Congressman.

It's true, it's a testament to the importance with which we all hold this subject and the respect that we have for you that there are six Members of Congress here at a subcommittee hearing, which is quite unusual in these parts.

Now, as I say, I am going to turn the floor over to Bob Trumbule, but I want to mention in advance that because we have eight witnesses, we are going to adhere rigidly to the 5-minute rule, in order to assure that there will be plenty of chance for informal interchange after all of you get through with your formal statements. So with that, I will yield the floor to Bob Trumbule of the Congressional Research Service.

STATEMENTS OF ROBERT TRUMBULE, SPECIALIST IN ENVIRONMENTAL POLICY, ENVIRONMENT AND NATURAL RESOURCES DIVISION, CONGRESSIONAL RESEARCH SERVICE; DR. ROBERT W. BROCKSEN, PROGRAM MANAGER, ECOLOGICAL STUDIES, ELECTRIC POWER RESEARCH INSTITUTE, PALO ALTO, CALIF.; DR. ELLIS COWLING, PROGRAM DIRECTOR, EPA ACID PRECIPITATION PROGRAM AND ASSOCIATE DEAN FOR RESEARCH, SCHOOL OF FOREST RESOURCES, NORTH CAROLINA STATE UNIVERSITY, RALEIGH, N.C.; DR. GEORGE HIDY, VICE PRESIDENT AND GENERAL MANAGER, ENVIRONMENTAL CHEMISTRY CENTER, ERT, INC., WESTLAKE VILLAGE, CALIF.; DR. JAY S. JACOBSON, PLANT PHYSIOLOGIST, BOYCE THOMPSON INSTITUTE, CORNELL UNIVERSITY, ITHACA, N.Y.; DR. GENE LIKENS, PROFESSOR OF ECOLOGY, SECTION OF ECOLOGY AND SYSTEMATICS, CORNELL UNIVERSITY, ITHACA, N.Y.; DR. ORIE LOUCKS, SCIENCE DIRECTOR, THE INSTITUTE OF ECOLOGY, BUTLER UNIVERSITY, INDIANAPOLIS, IND.; DR. VOLKNER MOHNEN, DIRECTOR, ATMOSPHERIC SCIENCE RESEARCH CENTER, STATE UNIVERSITY OF NEW YORK, ALBANY, N.Y.; AND DR. RUDOLF HUSAR, CAPITA, BOX 1185, WASHINGTON UNIVERSITY, ST. LOUIS, MO.

Mr. **TRUMBULE**. Thank you, Mr. Chairman.

My name is Robert Trumbule. I'm a specialist in environmental policy in the Environment and Natural Resources Policy Division.

I was asked to serve as the facilitator at the all-day seminar on acid precipitation held yesterday under the subcommittee sponsorship. I'm here this morning to briefly tell you what we did and how we did it and even more briefly to highlight a few of the interesting points which came under discussion.

Yesterday, eight of the country's foremost researchers in acid precipitation, along with support personnel, assembled at 9 a.m., and we were given the subcommittee's charge that they have a free-and-open discussion of various aspects of acid precipitation research. They also understood that they were to summarize and encapsulate the discussion to the point where they could brief you today on points of consensus, areas of uncertainty, and research needs.

To facilitate this, acid-precipitation concerns were divided into eight areas: sources, physical atmospheric processes, chemical atmospheric processes, deposition monitoring and trends, aquatic effects, terrestrial effects, other effects, and, for want of a better term, something called process to address the issue or what's next scientifically?

Today each of our experts will take 5 minutes to summarize one of these eight areas. I probably should tell you that we asked each scientist to summarize the discussion in an area other than his own specialty. This was done to avoid inadvertent embellishment, due to an in-depth knowledge of a given subject area, of what was discussed and agreed upon in yesterday's seminar.

It is our understanding that after this brief series of summaries, members of the subcommittee will want to engage the panel in questions and answers.

Before getting underway with the summaries, let me give you a few highlights from yesterday's most stimulating and, I might add, strenuous day. I will merely list these, as they will be elaborated upon later by the experts themselves.

No. 1, the role of ammonia in rainfall acidification must be included in an acid rain assessment.

No. 2, the role of tall stacks has probably been overrated.

No. 3, dry deposition plays an exceedingly important role in understanding acid deposition, but we have as yet inadequate ability to measure it.

No. 4, there may not be a 1-to-1 relationship between emissions and acid deposition.

No. 5, there is a need to look at the total chemistry of rain, not just pH.

No. 6, we must have long-term monitoring efforts, including monitoring of dry deposition.

No. 7, for aquatic impacts, the greater the reduction in the level of acid loading, the greater the uncertainty in the potential benefits.

No. 8, long-term whole ecosystem research is needed to understand terrestrial effects.

No. 9, it is biologically naive to consider acid rain apart from other air pollutants, all of which act together, and the same can be said for materials damage.

No. 10 and last, research shouldn't stop after mitigating actions have begun. There is a need to determine what effects our actions are having.

Without further ado then, let me introduce the first of our briefers, Dr. Volkner Mohnen, who will summarize the group's thoughts on the subject of sources.

Mr. **SCHEUER**. Can I introduce Dr. Mohnen?

Mr. **TRUMBULE**. Please do.

Mr. **SCHEUER**. Dr. Mohnen is Director of the Atmospheric Sciences Research Center, and he serves as research professor in the Department of Atmospheric Sciences for the State University of New York. He is a physicist with a minor in meteorology and astrophysics and has worked over the past 10 years in atmospheric chemistry, including acid rain. He also directs the Whiteface Mountain Rural Precipitation Chemistry Center in the middle of the Adirondacks.

Dr. Mohnen?

Dr. **MOHNEN**. Mr. Chairman, the summary of our findings is as follows:

Natural sources of sulfur in the eastern United States amount to about one-twentieth of the estimated manmade emissions. However, this ratio might vary considerably from region to region. It is recognized that overall sulfur emissions in the Northeastern United States have decreased over the past decade or so, while they increased in the Southeastern United States.

The existing emission inventories for sulfur from stationary sources, with utilities contributing about 60 percent, and from area sources are considered adequate at this time with an estimated uncertainty of around 20 percent.

Natural sources of sulfur are not an issue when discussing acid rain in the Eastern United States. The natural source strength of oxides of nitrogen is estimated to be about 10 percent of the manmade emissions in the eastern United States. However, the manmade source strength is known with a certainty of only 40 percent or so because of the nature of formation of oxides of nitrogen and because of the variety of contributors.

For example, transportation contributes one-third, industry and home heating one-third, and utilities one-third. All information shows that oxides of nitrogen have increased in the Eastern United States.

Finally, as far as ammonia emissions are concerned, our knowledge about source strength, either natural or manmade, is very poor. Evidentally the ammonia emission pattern is distinctly different from that of sulfur and nitrogen oxides. It reflects such factors as bacteriological activity in soils or location of feedlots or agricultural activity.

Since ammonia in precipitation may contribute to biological acidification, it is a parameter for acid rain that should be included. Whether or not trends in ammonia emissions exist is unknown.

Information needs are as follows: an improved inventory of NO_x emissions, ammonia inventories, and initiation of inventories for other materials that have the potential of changing the precipitation acidity—for example, emission inventories for calcium and potassium from manmade and natural sources.

Thank you very much.

Mr. **Scheuer**. All right. And now Dr. Rudolf Husar, professor of mechanical engineering and director of the Center for Air Pollution Impact and Trend Analysis, CAPITA. His research activities over the past decade were in the area of atmospheric transformations, transport, and removal of sulfur and nitrogen compounds. Dr. Husar is currently active in the long-term trend analysis of atmospheric aerosol concentrations and depositions.

Dr. Husar?

Dr. **Husar**. Mr. Chairman, once pollutants are emitted to the atmosphere, they are transported and dispersed by the winds, deposited to the ground, and also undergo chemical reactions on the way from the source to the receptor. I will address here the transport and removal processes.

The atmosphere cleanses itself from sulfur and nitrogen compounds by wet-and-dry-removal processes. Wet deposition by rain and snow is monitored in North America, and we can now estimate the amounts of wet deposition of sulfur-and-nitrogen compounds with reasonable confidence.

On the other hand, dry deposition onto the vegetation and soil in the absence of rain and snow is not and cannot be monitored today. Dry and wet deposition limits the residence time of sulfur-and-nitrogen compounds in the atmosphere to 2 to 5 days. During that time, the atmosphere moves on the order of 1,000 kilometers. Hence the region of impact of any source on ultimate deposition is on the order of 1,000 kilometers. Conversely, the deposition in any given location originates on the order of 500 to 1,000 kilometers from the receptor.

With the current meteorological information and long-range transport models, it is possible to estimate the direction of the source region where the chemicals in the rain originate. On the seasonal and yearly average, it is possible to estimate for any given receptor site—say, the Adirondacks—what amount of sulfur and nitrogen originated in wind directional sectors, let's say from southwest or Canada. However, only the aggregate but not the specific contribution of individual sources can be estimated.

Our understanding of the meteorology of precipitation events lasting for hours and days is incomplete. Some effects respond to seasonal or yearly dosages for which our monitoring and modeling methodology is adequate. For short-term episodic deposition, our prediction in monitoring capabilities are not adequate.

Our panel feels that the role of the tall stack as a major cause of the so-called long-range transport has been overemphasized in the past at the expense of the total amount and spatial distributions of sulfur-and-nitrogen emissions. Research needs include dry deposition data as well as data and modeling capabilities on the short-term episodes.

Mr. SCHEUER. Thank you very much.

We'll now hear from Dr. George M. Hidy, vice president and chief scientist for Environmental Research Technology, Inc. Dr. Hidy is project director for the Electric Power Research Institute's sulfate regional experiment.

As a scientist and also dedicated trout fisherman, Dr. Hidy has extended his interest in atmospheric chemistry to acid deposition phenomena of all kinds.

Dr. Hidy?

Dr. HIDY. Thank you.

Mr. Chairman and members of the committee, my area is to discuss with you atmospheric chemical transformations. So, I will present to you some summary sentences about our conclusions. And I am happy to tell you that, speaking for the group, we are all in agreement on these conclusions.

The first conclusion is that sulfur and nitrogen oxides are the predominent acidifying species in the atmosphere. However, ammonia biologically may be an acidifying species after it reaches the ground, and its chemistry therefore needs to be considered.

The second point is, to understand acidity in precipitation, it is essential to measure the major anions and cations in precipitation, especially the combination of hydrogen ion, sulfate, nitrate, and ammonium. The analysis also should include other ions such as potassium, sodium, calcium, magnesium, chloride, bicarbonate, sulfite, and phosphate.

The third point notes that atmospheric chemistry, per se, is not crucial to the biologist. That is, in the biologist's view, the geographical distribution of total sulfur and nitrogen oxide deposition is really most important. The chemical form produced in the atmosphere is of relatively little consequence compared with the biological assimilation taking place in the ground and in the surface waters.

Next, wet deposition and dry deposition of sulfur are roughly equal in magnitude, and may vary from place to place.

Most important, from a control standpoint is the conclusion that both wet-and-dry deposition of sulfur and nitrogen oxides may not occur in a 1-to-1 proportionality to either ambient concentration or emissions. There is mounting evidence that sulfate and nitrate in cloud and precipitation water are not in a 1-to-1 proportionality to ambient air concentrations or emissions.

Oxidant species in the atmosphere—like ozone, hydroxyl radicals, hydrogen peroxide—may be controlling the chemistry in the air.

Thus, important questions arise about the control of chemical precursors.We cannot necessarily guarantee the effectiveness of emissions control of sulfur and nitrogen, per se, for reduction of atmosphere acidity.

By way of continuing research, we recommend that research be emphasized to clarify the proportionality relationships for sulfur and nitrogen in dry deposition, particularly.

Likewise, we feel that the chemical components limiting atmospheric sulfate and nitrate production, in relationship to emissions, need considerably more study.

Thank you.

Mr. SCHEUER. Thank you very much, Dr. Hidy.

Next we'll hear from Dr. Jay Jacobson, a physiologist with the Boyce Thompson Institute in Ithaca, N.Y. Dr. Jacobson has performed experimental research on the effects of ozone, sulfur dioxide, acid rain, and other pollutants on vegetation for the past two decades. He's a member of the excecutive committee of the national atmospheric deposition program, and is organizing a symposium on the effects of air pollution on farm commodities, that will take place here in Washington, D.C., in January next year.

Dr. Jacobson?

Dr. JACOBSON. Thank you very much, Mr. Chairman.

Members of the subcommittee and ladies and gentlemen, one of the more obvious visible manifestations of the expenditure of research dollars recently has been the development of deposition-monitoring networks, and it is my task in the next few moments to express to you some of the conclusions of this group concerning deposition monitoring.

I would like to begin by raising a question Mr. Chairman, paraphrasing some words that you used in your introduction a few minutes ago.

What does information from deposition monitoring permit us to do?

The first thing it permits us to do is to determine changes in the geographical distribution of the deposition of acids from the atmosphere. In other words:

Is the deposition of acids from the atmosphere increasing into the Southeastern United States?

Is it increasing into the Western United States?

The deposition monitoring programs will allow us to do that, to understand the answers to those questions in the 1980's and 1990's.

Mr. **Scheuer**. Not only the question of is it increasing as a generality, but: Is it increasing as a result of increased pollutants from identifiable sources *x* miles away?

In other words, as somebody mentioned, there is no linear relationship that we can ascertain now, 1-to-1 relationship between increase in polluting sources and an increase in deposition.

What we really have to know is: Is the relationship 0.9 or 1.1—sort of around 1-to-1—or is it 0.3 or 0.1 or less?

Is it approximately a linear relationship, give or take 10 or 20 percent, or is the relationship—is the cause-and-effect relationship so insignificant that it's more or less negligible?

We have to know this as a public policy matter, in order for us to have any right to think about laying on billions of dollars worth of costs to the industry.

But I don't want to interrupt your testimony further.

Dr. **Jacobson**. We understand that this controversial issue is one of the most difficult things for you.

Mr. **Scheuer**. That really is the question that the Energy and Commerce Committee will have to face early next year, as they begin consideration of the Clean Air Act: What is the relationship? If it isn't a linear relationship, what is it?

Dr. **Jacobson**. Right. And also, the deposition monitoring will help us understand the relationships between sources and receptors. It will not answer the question alone, but it will assist in the research that's necessary to answer that question.

In addition, deposition monitoring will help us understand time trends. That is, during the next decade or two, what will the changes be in the deposition of acids in different parts of the Nation?

In addition to that, we also believe it is necessary to understand whether there will be any changes in the global background of substances that are deposited from the atmosphere.

And finally, what will be the impact of control strategies that may be initiated by your decisions on the deposition of acids from the atmosphere?

The deposition monitoring networks that are now in operation, or may come into operation soon, will allow us to answer these questions. Generally, there are three types of deposition monitoring studies that are needed:

One is the regional study that is very intensive and is at a research level.

Second, the national monitoring network, such as the national atmospheric deposition monitoring program.

And, finally, the global monitoring of background levels in deposition of substances from the atmosphere.

So, this group believes it is of critical importance to maintain, on a continuous basis, over long periods of time, these types of deposition monitoring efforts. The great challenge, then, is how to maintain the longevity of these programs.

Mr. **Scheuer**. Thank you very much, Dr. Jacobson.

Dr. **Jacobson**. I have one more point. Do I have time for it?

Mr. **Scheuer**. Yes.

Dr. **Jacobson**. In my 5 minutes——

Mr. SCHEUER. You stopped to draw a breath, and so I thought you were finished.

Dr. JACOBSON. That is necessary once in awhile.

As you probably know, there have been improvements, considerable and important improvements, made in the quality of deposition monitoring in this country, and these improvements in the quality of the monitoring of atmospheric deposits continue to be necessary.

Of highest priority is the development and use of methods for the collection and analysis of dry deposition, including metallic elements. As you may know and have heard from the others who have briefed you just before me, we do not now have methods that are accurate and precise for the collection and measurement of the dry components of atmospheric deposition. The reason for this need is because dry deposits provide a major input of acidifying substances to the landscape.

Thank you very much.

Mr. SCHEUER. Thank you very much.

And now we'll hear from Dr. Orie Loucks, science director for the Institute of Ecology, which is a national consortium of universities concerned with large-scale research. Dr. Loucks is trained in forest systems methodology, and has served as professor of environmental studies at the University of Wisconsin. Recently, Dr. Loucks has served as a member of the aquatic impact subgroup of the United States/Canadian acid-rain assessments.

We're very happy to have you here, Dr. Loucks.

Dr. LOUCKS. Mr. Chairman and members of the committee, our discussions yesterday, in the area of aquatic effects, indicate much agreement as to the changes being induced in aquatic systems:

First, that changes in surface-water chemistry are evident when early pH and sulfate measurements are compared with recent data for lakes and streams in designated sensitive regions. The changes are clearly linked to the magnitude of acidic inputs.

Second, that the reductions in the fisheries that have occurred in the subset of lakes with altered chemistry is also reasonably well linked to the acidic inputs.

And, finally, there is agreement that some of the responses in water chemistry can be recognized as a time trend over several decades, although this evidence is available from only a few locations.

Disagreement within the group exists in a number of areas, of which the following four are probably important:

First of all, there is disagreement as to the importance of nitric acid inputs in the acidifying process.

Second, there is some disagreement as to the importance of the threat to endangered species, particularly at high elevations, but in other habitats as well, and the threat to genetic stocks among these species.

And there is disagreement with respect to the tools available for defining acid-loading tolerances in aquatic systems, and as to the reliability of preliminary models that we have for describing that tolerance.

Mr. MITCHELL. Mr. Chairman, could we have a definition of what "areas of disagreement" means?

There are eight of you there. If one person disagrees and seven agree, is this still in the area of disagreement, or does it have to be sort of half and half?

Dr. LOUCKS. We didn't vote on any of these questions. We have been reading the same literature over a period of time. There have been various kinds of critiques done on this literature. The topics that we have raised here are topics which all of us know have been areas of disagreement within the scientific community.

We reviewed them briefly——

Mr. MITCHELL. So most of you would agree that there is disagreement in that area?

We don't have half—we don't have five of you saying that this is so, and three not so? That would be an area of disagreement.

Your area of disagreement is what everyone agrees, that the scientific community doesn't really have the answers?

Dr. LOUCKS. That's right. It's part of the unfolding science. By a year from now, some of these areas might be an area of agreement.

Mr. MITCHELL. I just wanted to know what the term meant. Thank you.

Dr. LOUCKS. One other area of disagreement and uncertainty has to do with the magnitude of the apparent irreversibility of effects on certain resources from delaying abatement.

There are some people who find the evidence persuasive, that calcium and magnesium are being depleted from soils as long as these elements remain available on severely acidified watersheds, however, they are no longer available in sufficient quantity for rapid growth. The calcium and magnesium functions in aquatic systems to provide a certain part of the buffering capacity in those lakes.

Thus, from the point of view of whether we can afford to wait 5 or 10 years, one would conclude that if you accepted this evidence, then some small number of watersheds would become more strongly acidified in this time interval, that is, those that have lost a significant quantity of calcium and magnesium during this time would have suffered a relatively irreversible loss.

Not everyone agrees with that evidence, however. Uncertainty can be expressed perhaps most clearly in terms of our efforts to define the relationship between the dose from deposition monitoring, which Dr. Jacobson just described, and the magnitude of the effects being observed. This we call a "dose/response" relationship.

Uncertainty is rather smaller at the high treatment end of this dose spectrum, and much larger as one moves toward what we believe might be a no-effect level. We look at research needs, then, as needing to be focused in three areas:

First of all, comprehensive monitoring of water quality and biological effects. We have no such monitoring program in place at this time.

Second, research on the processes in watersheds required to understand the effects that have been alleged, and to improve our confidence in describing the causal links in acidification.

Finally, the program of response model development and testing, building on the data in these first two areas to document how the effects in streams and lakes relate to the acid input and, therefore, to determine what benefits can be expected from certain levels of abatement.

Thank you very much.

Mr. SCHEUER. Thank you very much.

We will now hear from Dr. Ellis Cowling, Associate Dean for Research in the School of Forest Resources at North Carolina State University. Dr. Cowling has been engaged in research on atmospheric deposition since 1970, and presently serves as Chairman of the National Atmospheric Deposition Program, a multiagency program which provides the only national data base on acid rain in all regions of the United States.

Dr. Cowling, as well as others of you here, has appeared repeatedly before this committee, and he has been a great contributor to our work. We are particularly delighted to have you, Dr. Cowling.

Dr. COWLING. Thank you, Mr. Chairman and members of the Congress. It's a pleasure to be here today. I think you should realize that the comments you are hearing from the eight of us are directly germane to the nine areas of scientific work that are a part of the National Precipitation Assessment Program.

With that comment, let me go on to talk about terrestrial effects—my assignment with regard to our group here today. By "terrestrial effects," we're talking about both agriculture and forestry. In contrast with our knowledge of marked detrimental effects of acid deposition on surface waters and aquatic life, as Dr. Loucks has just described, our knowledge of possible effects on agricultural crops and forests is comparatively meager. Also, for reasons that pertain to the nature of forest soils, the longevity of forest trees, the diversity of forest plants, and the management systems used in forestry, forests are more likely to be affected in a severe way by acid deposition than agricultural crops.

The most likely effects of acid precipitation on forests, trees, and agricultural crops include, on the one hand, leaching of nutrients from soils and, on the other hand, predisposition of forests or agricultural crops to other stress factors, such as drought, air pollution, diseases, or insects.

Numerous specific biological effects of simulated acid rain have been demonstrated in controlled field and laboratory experiments. But reliable evidence of economic damage to agricultural crops, to forests, and to biological processes in soils by ambient, everyday, acid deposition in the out-of-doors, has been reported only rarely.

New evidence of possible effects of acid precipitation on forest trees has developed recently, both in this country and in Europe. The first includes an apparent linkage between the acidity of precipitation the aluminum concentration, in acidified soils, death of feeder roots, and die-back of spruce. This linked series of effects is quite widespread in Germany and also in Sweden. Evidence of a similar linkage is now becoming apparent here in the United States and Canada.

The second piece of evidence is in the Pine Barrens region of New Jersey. I think you all know there's a strong correlation between the width of annual rings in a tree and the amount of rain. But Arthur Johnson of the University of Pennsylvania has shown there is a stronger a better correlation between the acidity of water in the Pine Barrens region and growth than the amount of rain and growth—a very surprising thing.

In conclusion, let me say that more long-term—by that we mean 10 years or more—research on whole ecosystems is needed to provide an improved understanding of the balance between both beneficial and detrimental effects of atmospheric deposition on forest ecosystems. This will require greatly increased multiagency support of research which will attract the interest of our able scientists in the fields of soil science, forest hydrology, tree physiology, forest pest management, meteorology, and so on. The Integrated Lake Watershed Acidification Study sponsored by Dr. Brocksen's organization, EPRI, and the Hubbard Brook Experiment Forest sponsored by the U.S. Forest Service and the National Science Foundation are good examples of such studies.

Thank you, very much.

Mr. SCHEUER. Thank you, Dr. Cowling. We will hear now from Dr. Gene Likens, professor of ecology at Cornell, who has been working on acid precipitation for 20 years as part of the Hubbard Brook Ecosystem Study. Dr. Likens' research specialty is in aquatic ecology and analysis of natural ecosystems. He is currently president of the Ecological Society of America and a member of the National Academy of Sciences.

Dr. Likens?

Dr. LIKENS. Thank you, Mr. Chairman, Members of Congress.

My task is to briefly summarize a variety of topics that we considered yesterday. We considered them rather briefly, but we came to some consensus about them. First of all, there is a variety of chemical changes that occur in soils as a result of acid precipitation, most notably the leaching and mobilization of ionic forms of aluminum. These changes in soil chemistry may represent long term, that is—decades to centuries effects which are slowly reversible—that is, up to thousands of years.

Detailed, quantitative, and experimental data are badly needed on the role of hydrogen ion and sulfate ion in soils and are required for predictive modeling of the output and effects of acid drainage water from these soils as it flows into lakes, and on the effects on those lakes.

Second, the effects of acid precipitation are seen most clearly in headwater streams. High, including toxic, concentrations of hydrogen ion and aluminum ion, are frequently found during snowmelt periods in such streams. Again, quantitative and experimental information on chemical transformations in streams is necessary to predict the inputs to lakes, because these stream ecosystems themselves may alter the chemicals that are passing through both in concentration and in amount.

Third, we agreed that it is biologically naive to consider the effects of acid precipitation in isolation of other air pollutants, such as ozone, sulfur dioxide, and metals. Each of these pollutants may act simultaneously or in various combinations to produce biological effects. As the other members have alluded to, we badly need additional long-term, continuous research in natural ecosystems to evaluate these effects.

Fourth, material corrosion effects are well known, but occur, again, from combined effects of various air pollutants, including acid particles and sulfur dioxide. We believe that the quantitative cost of this damage should be assessed clearly, and as quickly as possible, to develop more realistic cost-benefit analysis relative to this type of air pollution effect.

Fifth, some health effects have been reported in areas with rather primitive water systems, such as with surface runoff or cistern water sources, where the water passes through metal pipes and where levels of lead, zinc, or copper may be increased to toxic levels; however, the extent of this problem is not well known.

Thank you, Mr. Chairman.

Mr. SCHEUER. Thank you, Dr. Likens.

Dr. Robert W. Brocksen, our last witness, is manager of ecological studies programs for the Electric Power Research Institute. His chief responsibilities include acid precipitation and toxic substances research. Dr. Brocksen received his Ph. D. from Oregon State University, and is trained as a specialist in limnology and fisheries.

Dr. Brocksen?

Dr. BROCKSEN. Thank you, Mr. Chairman and Members of Congress.

The subject that I was assigned is the amorphous one of where we go from here scientifically. You have heard what the state of the science is from the other members of the panel. I would like to suggest that we have agreed upon approaches to our science to get answers to the problems and the questions that you are asking here today. We are just beginning to gain insight into effects of dose-response or cause-and-effect relationships.

Changes in the emission levels may change the questions that we ask. For example, if there are some immediate control or mitigative methods instituted, our questions may be, "Have these done any good?" rather than, "Are there significant problems that warrant them?" However, the general research in this problem area should continue over the long-term, with the long-term being the 20- to 30-year time frame in terms of some of the monitoring mentioned earlier.

The efficacy of mitigative action at this time is an area of relative disagreement among scientists; however, considerations of any control options, we feel, should incorporate the appropriate environmental considerations. We don't want to shift the burden from one area to another without reasonable assurance that it will be environmentally sound.

Management questions should be incorporated in our research in the future, and we should ask the questions: How many lakes are being affected? How many lakes have lost their fish? If we make a decision to control emissions, how many lakes will be restored as a result of that action? How many lakes will have a viable fishery?

The approach to future research, we believe, should provide a framework for the integration of scientific findings. Such research is expensive, but it's more likely to provide information useful for the decisions that you have to make.

In the past—and one of the reasons we have a divergence of opinions is because the basic scientific research has been underfunded—research has been focused on the discovery of new facts, there has been in-depth pursuit of some of the less appropriate areas, research was not necessarily directed to management questions, and there was a divergence of inquiry. We feel that basic scientific research can be incorporated into scientific problem-solving research, and that ecosystem response to changes in amounts of acid deposition should be investigated and should emphasize the management questions, so that we have a framework for the integration of scientific findings.

Last, we believe that regional amplification in research is most important. For the most part, the research has been directed toward those areas that we know are receiving heavy acid precipitation inputs. We believe that we should have counterpart studies in evaluating regions that are not perceived as being currently impacted for comparative purposes.

I thank you, sir.

Mr. Scheuer. Thank you very much, Dr. Brocksen.

I want to thank you all for having helped us get through your initial presentations in substantially less than an hour.

Now we will commence some questionings. I am going to yield shortly to my colleague Bill Carney, ranking minority member of the committee.

I would like to suggest to my colleagues that we keep this very informal, and if any of you have a question that follows on logically to conversation, please interject. And I would likewise suggest to the panel that as one of you may be asked a question in response, if any of the others feel an elaboration or critical comment or additional supportive comment is appropriate, by all means, break in. So we will keep this as informal as possible, to give everybody a chance to participate and have a good flow of conversation.

Congressman Carney?

Mr. Carney. Thank you very much, Mr. Chairman. It's rather difficult to ask a panel of eight scientists questions under this forum, but we will try to do the best we can. I think the questions, when considering time, would have to be rather broad-based.

Certainly there seems to be agreement that we have to enhance our monitoring programs on three different levels: The regional level, the national level, and international level. Is there anyone on the panel that would disagree with that statement?

[No response.]

Mr. Carney. For the record, no one has indicated they would disagree.

The next question I have would be to anyone on the panel. That is, the present methods that we use to monitor acid precipitation, are they generally accepted by the scientific community, or is there disagreement with the methods used?

Dr. Cowling. We're doing fine on the wet side. We're not doing so fine on the dry side.

Mr. Carney. I think from testimony we received, that was an area that one gentleman pointed out as being in agreement: That the dry side aspect of this is up in the air, for lack of a better term. [Laughter.] And according to Dr. Mohnen, if there was enough water up in the air, it would eventually be on the ground. We won't get into that. [Laughter.] The point that I'm trying to make, then, is the methods we are using to monitor the disposition transformation of the various elements we are dealing with are generally accepted by the scientific community.

OK, now I am going to ask a question and it's probably rather difficult for you to answer. Faced with the fact that our Clean Air Act is expiring, this particular Congressman has the belief that acid rain is indeed a time bomb that we're faced with and we're going to have to take some type of action. One, I think there should be a commitment from this country to enhance the monitoring capabilities and to enhance the data base to start to establish trends. Certainly I think everybody would support in this Congress that now we are faced with the problem of what do we do to prevent further degradation. It's difficult with our timeframe but I would ask anyone what you would do, as scientists, if you were put in my position, to start in 1982 to reverse the trend of the problem, from a standpoint of legislation. And I would ask that if you answer the question, please try to do it in a form that we can convert to public policy and not in a scientific form.

Dr. Mohnen? I love throwing hand grenades and leaving.

Dr. **Mohnen**. One should recognize that science is a process. In other words, we start with an action. Then we observe how nature reacts. And after that, we come forth with a new answer. Obviously, you don't have time. This is the understanding I received from the urgency of your question.

The goal in atmospheric sciences is to establish a relationship between emissions and depositions so that some kind of rollback can be achieved. You have heard today, I believe, that science is not yet in a position to give you this rollback formula. The time, how long it will take, we don't know either. However, lack of this solid, scientific evidence might induce actions that are more philosophical than practical.

Through advanced coal washing one can save, within a period of 2 years or by the end of 1984, a total of 2.5 million tons of sulfur dioxide per year. This will represent more than 10 percent of the total current utility emissions which are around 18 million tons per year. With this action, which probably is the least costly action of all the propositions, science would be in a position eventually to test the effect upon deposition, which is the first to show up in sensitive regions. Once it has been established that there is a response to this 10 percent change—which presents, in my opinion, a major contribution—once we have established that, indeed, acid rain does respond in sensitive areas, then we are ready for the next step.

Ultimately, my personal feeling, not that of the panel, is that I would object to retrofit action on old powerplants. I believe that there is a total amount of money available that either can go into retrofitting old clunkers or it can go into the design and construction of new powerplants that are based on cogeneration. That is a philosophical point of view. A cogeneration powerplant might give us efficiencies of 60 percent, or 50 to 60 percent, with good control of pollutants while an old clunker still hangs around 30 percent or less, and with additional control added to it would just prolong the life of this old powerplant.

I must again point out, it's my own opinion, not that of the panel.

Mr. **Carney**. This has just stimulated many questions I have. I know we're working under the 5-minute rule. I'm going to ask two questions now. One, at our last hearing, we had a very prominent scientist from the State University of New York, who said if you reduce 10 percent of the emissions you might not get any effect. If that same scientist said do that now, could we establish an effect?

Dr. **Mohnen**. Yes. The question at the Lake Placid hearing was specifically a 10-percent reduction of sulfur emission as its impact on the Adirondacks. The 10-percent reduction will show up somewhere. I did not say it would show up in Congressman Mitchell's district. As a matter of fact, I warned him. I said do not expect this. But it will show up somewhere in Canada. We must be in a position to detect that emission change somewhere on this globe.

Mr. **Carney**. That's the problem we're faced with as legislators. If it doesn't show up within our own air systems, under our own umbrella, then we are going to be back to the same problem that we had. We'll hear the rhetoric that EPA doesn't know what they're doing, and that the Clean Air Act is ineffective. We've just added billions of dollars to industry and we haven't cleaned the air at all. That gives us a problem, which makes me think of my next question. I don't mean to criticize. I'm just trying to alert the scientific community as to the problems we, as legislators, have. I hope we can work it out so we can come up with effective answers.

That makes me switch to Dr. Brocksen, who said, or seemed to indicate, that we should take a management approach to this, and who said let's find out how many lakes are going to be affected. Someone has to make a decision. For example, will we allow 632 lakes to die? The scientific evidence says that what we're doing now will only kill 500 lakes. Let's not do anything. So we kill 500 lakes in the next 10 years, OK?

Now, we run into a problem. I think—and this is the mind of a legislator—we've just killed 500 lakes. And in the next 10-year period, perhaps the amount of lakes that would die would be significantly less because we have killed the most sensitive lakes. Then we would never do anything. Do you understand what I'm trying to say?

Dr. **Brocksen**. I understand what you're trying to say, but I don't understand what I'm supposed to respond to.

Mr. **Carney**. As long as you understand. What I'm trying to say is how can we do something like that? If we take that approach, if we say we have to catalog, in the first place, we're working in a very short time, a very short window of time dealing with, as we see it, the only thing we can use as a vehicle now is the Clean Air Act. And if we were to try to make those evaluations, it might prohibit us from moving forward to taking any type of remedial action or any type of action that would stop the continuance of lake degradation, the atmosphere itself, problems involved with forestry, and everything else.

Dr. **Brocksen**. I'll respond to your question or your statement in the following manner. There is a lot of disagreement with respect to the timeframe over which these things might be occurring and the extent to which they are occurring. What was suggested by Dr. Loucks earlier, what has just been suggested earlier by Dr. Mohnen, and what was highlighted as one of the 10 points that we stated earlier, is that there is a general consensus that there's a greater scientific uncertainty the more severe the action.

What we're saying is that perhaps a 10-percent reduction could be effected and we should see if indeed there is any effect. You may find the difference in the atmospheric levels. Will you find the difference in the number of lakes or will you see some remedial repair in those lakes? Those are scientific uncertainties, and I'm not prepared to answer it any further than that.

Mr. SCHEUER. Will my colleague yield?

Mr. CARNEY. I'll be glad to yield to the chairman.

Mr. SCHEUER. Working at this incremental approach, I take it the panel is satisfied that there is a very significant, positive cost-benefit calculus to going ahead—and requiring at least universal coal washing, and that that will produce a 10-percent reduction in pollutants, in polluting effects that clearly is worth the cost. Is there agreement on that?

Dr. JACOBSON. We did not deal, as a group, with the question of control technologies. We do not have experts within our group. When we talk about control technologies, we're speaking as individuals.

Mr. SCHEUER. Was it Dr. Mohnen who recommended that we go ahead immediately with universal coal washing that would produce roughly a 10-percent reduction of sulfur dioxide?

Dr. MOHNEN. I suggested so. It's based on an EPA report that's a public document.

Mr. SCHEUER. Is there a consensus here that that 10-percent reduction in pollution that would be reached as a benefit of requiring industry to undertake the cost of coal washing would be a cost beneficial mandate for Congress to lay on American industry? Is there any agreement on that?

Dr. HIDY. I would just like to comment personally on that. We didn't address either cost or benefits. Coal washing is one option of many.

Mr. SCHEUER. It's an inexpensive option.

Dr. HIDY. It's relatively inexpensive.

Mr. SCHEUER. Flue gas scrubbing is very much more expensive. We're in a world where we have to make practical choices. We're going to have to make them pretty soon in the next few months. Do we reach toward flue gas scrubbing, as the Japanese have done with all of their installations, with all of their utilities and manufacturing installations? Is that something that can be justified on a commonsense basis of costs and benefits? We really need some help from you in making these practical judgments. Is there any consensus that at least coal washing is justified at this time?

Dr. HIDY. I think one of the things that Dr. Brocksen mentioned about coal washing, must be appreciated. If you take the pollutant material out of the coal prior to the time it's burned, the sulfur you take out includes some other cocontaminants which can be quite toxic. So one has to determine where that hazardous waste is going to get dumped and what kind of environmental impact that dumping will have. The same question applies to the sludge from scrubbers. For sulfur removal systems, the total system operation and impact cost benefits have not been completed, in my opinion.

Mr. GREGG. Mr. Chairman, can I interject here?

Mr. SCHEUER. Yes.

Mr. **Gregg**. I'd like to ask Dr. Hidy where it's being dumped now, this extremely toxic material that you've been taking out of the system. Isn't it being dumped in New England? I mean, you're asking us to take their toxic material and dump it in New England, rather than have them take it and get the negative impacts.

Dr. **Hidy**. I'm not referring to the sulfur alone. There are other contaminants in coal that are highly toxic, like carcinogens and toxic metals, which are removed by the solid liquid extraction process. These have to be removed and dumped somewhere. I believe that you're referring primarily to the sulfur and nitrogen that come from coal combustion, as well as trace metals in fine particles that are released after filtering or electrostatic cleaning of the flue gas.

But one point I would hope that this committee understands is that from the point of view of atmospheric science we consider the transport and dispersion of emissions to be everybody's problem. We cannot provide you with a quantitative means of singling out the impact of 20 powerplants in the Midwest or Chicago or Milwaukee or a given city. If you look objectively at where pollution comes from in the Eastern United States, it comes from everywhere during the course of mixing and transport from nearby and distant sources. Your option, really, is, in my opinion, a classical and intuitive one requiring an integrated or aggregated rollback of emissions from every source, not just a few.

Mr. **Carney**. I would like to speak, and then I will give up my time to the Congresswoman from Rhode Island. The problem that we're faced with is I don't think the Clean Air Act is going to say: "scrub coal, do this, do that." What the Clean Air Act is going to try to do is to establish the national ambient air quality standards in relationship to acid rain, and that's what we're faced with. We're going to have to try to find ways for the polluters to meet those qualities, or the standards that we have set. And this is the problem that we have: Who is going to help us set the standards? Second, how do we trace the source of pollution identified and take action so that it would reduce that pollution to meet the quality standards?

And then, the third problem, which I constantly go back to Dr. Mohnen on because he was the one who jogged my mind on this and it seems to be a very significant thing to me now, is that if we suggest those actions, hoping to get the reaction—that is a reduction of pollutants and an enhancement of the air quality—and if it doesn't happen, where are we? We're back to square one again, and this is the frustration that I was faced with. Maybe I didn't say it well enough when I asked the question: What would you do if you were in my seat?

Dr. **Likens**. Mr. Chairman, could I possibly respond briefly to this?

Mr. **Scheuer**. Go ahead.

Dr. **Likens**. I think one of the problems is that we have entered a realm in which we are giving our opinions as scientists rather than our scientific evidence. We didn't discuss this issue in any depth yesterday. It's not an issue that many of us have any more than an opinion as an informed citizen, if you will. But there are some matters that must be considered.

The entire issue, I think, must be considered. If we reduce the emissions of sulfur by 10 percent, which is something that many of us might strongly support, that could be totally ineffective if we increased at the same time the emissions of nitrogen oxides by 10 percent. Or, as is occurring in New England and elsewhere where many homeowners are burning wood. This is widely done currently and we know little about the effect of that kind of emission to the atmosphere.

And I think we do ourselves a real disservice when we launch into techniques of repair without considering all the various ramifications that might be involved. We know, for example, that the nitrogen oxide emissions to the atmosphere have increased tremendously in the United States since 1940. We also know from the data that we have that the nitric acid contribution to acid rain has increased dramatically in the last decade or two. Changing one component and not considering the others, it seems to me, is not a realistic option.

Mr. SCHEUER. Let me say that we want your opinions and we want your value judgments. We're going to have to make opinions and value judgments, and we really don't have the knowledge base, most of us, to do it. And since the precise knowledge base may not be existent now to make precise judgments, we have to do the best we can in this most imperfect world. And so we want your value judgments.

We have to decide how far we are going to reduce the ambient air quality, how far we're going to reduce the permissible level of polluting effects in the ambient air quality standards. And we have to do it in a way that is cost effective and sensible.

We cannot reduce them so far so fast that we are requiring outlandish and unsupportable and unaffordable capital investments by industry that would have a devastating effect on our ability to be a productive economy, and as we said before, sell our goods and services around the world.

Now these are very difficult questions involving all kinds of guesstimates. We have to make them, and we hope that you will liberate yourselves from a slavish respect of facts and an unwillingness to make any recommendation that isn't supported by specific factual, analyzable data, because if we waited for that, we wouldn't be able to do anything now.

As my good colleague, Congressman Shamansky, the Congressman for the Ohio River Valley, who was here to keep us honest, would say, we would be flying blind. We cannot afford to fly blind. We have to fly on instruments. The instruments cannot be perfectly calibrated, but they are going to tell us enough that what actions we take will be sensible, will be based on reasonable judgments of costs and benefits.

And the question is, how far do we go and how fast do we go there in a way that is justified by a reasonable expectation of benefits in exchange for a reasonable level of costs in increasing ambient air quality standards and reducing the various levels of pollutants? And we need your value judgments in this area.

Dr. COWLING. Could I offer judgment here?

Mr. Carney asked what to do? There are a great variety of things that can be done. An effort that results in a net decrease in hydrogen ion loading to ecosystems will be beneficial.

You are considering in the Congress now——

Mr. Scheuer. Excuse me. How much of an effect at how much cost? This is the question.

Dr. Cowling. I understand. You have before you now legislation proposing a relaxation of standards for nitrogen oxide emissions for vehicles. I think we can say that maintaining the NO_x standard should be considered together with coal washing.

It would be highly cost effective to hold the line on nitrogen oxide emissions for exactly the reasons that Dr. Likens indicated.

Mr. Scheuer. For moving vehicles?

Dr. Cowling. For vehicles. Dr. Hidy spoke about an aggregate method of approach. One of the bills that has been proposed has to do with the creation of a 31-State amelioration region. I think that's a very constructive way to think, that every State should do its part toward reducing the total deposition that is required.

Those decisions can be made within individual States. But a general recommendation about the average percentage decrease that each State ought to be expected to achieve is a highly desirable way to go. It's also equitable among the States. And I would suggest to you that there are certain States that have done a more effective job of limiting their emissions in the past than have others.

I would propose to you that a general reduction of emissions from all States by an equal percentage, not calculated on the basis of present emissions but calculated on the basis of emissions on the date the Clean Air Act was passed, would be a very equitable way to give credit to those who have been vigorous in their pursuit of emissions limitations and to not give credit to those who may have delayed.

Last Friday, I got this little chart which shows the average percentage change in sulfur dioxide emissions from utilities in various States, and it's clear that the State of Michigan should get a gold star.

Mr. Scheuer. Excuse me. I would ask unanimous consent that that table be placed in the record at this point.

[The document referred to follows:]

MIDWESTERN UTILITIES SO_2 EMISSIONS SO_2 EMISSION

(1,000 tons)

State	1975	1980	Percent reduction (increase)
Illinois	1,245	1,019	18.2
Indiana	1,254	1,375	(9.7)
Kentucky	361	324	10.3
Michigan	964	534	44.6
Ohio	2,617	2,137	18.3
West Virginia	977	898	8.1
Total	7,419	6,288	15.2
Ontario hydro	343	451	(31.4)

Dr. COWLING. This chart shows that the State of Indiana has a 9.7-percent increase in sulfur dioxide emissions whereas the State of Ohio has an 18.3-percent decrease in the years between 1975 and 1980. It is obvious that we ought to look upon Michigan, Ohio, and Indiana each in a different light in view of their different efforts to decrease their emissions of sulfur oxide from utilities during the last 5 years.

I think this chart also shows something that we must also recognize—that Canada, too, makes a contribution, albeit a small one, to the total emissions from this region, but they are making significant efforts now to reduce their emissions.

So I would propose for Mr. Carney's consideration the possibility of encouragement from the Congress, be it a law or in some other way, that each State be asked to do its part. I think this is sound biologically. It is sound climatologically. And I believe it is sound politically. It does not take an expert in politics to think that we are all in this together. The exchange systems for air pollutants among the States are very effective, and we must include the provinces of Canada as well, so that an equal percentage decrease among all emitting States with respect to both sulfur and nitrogen oxides, based on the date that the Clean Air Act was passed, is a possible mechanism for dealing with acid rain. The idea is sound, climatologically, biologically, and politically.

Mr. SCHEUER. Thank you very much, Dr. Cowling.

I would like to recognize Claudine Schneider, a very active and contributing member of the subcommittee.

Mrs. SCHNEIDER. I guess it cannot be said enough by members of this committee that it is critically important that you, as scientists, take into deep consideration the formulation of policy recommendations, as has already been mentioned. I am rather discouraged to learn that as a few of you had mentioned, you really had not looked into the cost-benefit analysis.

As disturbing as it is, the debates that will take place on the Clean Air Act and on this issue of acid rain on the floor of the House will be laughable, and I will recognize that many of you will probably be in a position of mere screaming, because the debate in this House is not always based on fact and oftentimes rarely based on scientific information. The question that I can just imagine being raised right now is, Well, how many people have died from acid rain? How many fish have been killed? How many trees and forests have disintegrated?

On that same side of the argument, we will be told that the automobile industry is in deep trouble and that any efforts to infringe upon their activities will have a negative impact on employment. And, of course, we will have the whole issue of jobs brought to our attention. There will also be serious lobbying on behalf of major industries who are not at all interested in complying with some of these laws. I think it is critically important that you as scientists recognize the difficult situation that we are in and that we are groping and begging for some type of basic information that we can give that, if not definitive, will at least imply that this is a problem that we must begin to deal with today, lest we face more difficult impacts 5 or 10 years from now. This debate is coming right around the corner.

I do recall the very outstanding testimony that Dr. Cowling presented to this subcommittee a couple of months ago. I think that after we had a great deal of scientific discussion and we had talked all around the issue, I said to him, "Well, how are we going to solve this problem?" Fortunately, I very much appreciate your straightfoward answer which I still remember, and it was focused on controlling auto emissions and also fossil fuel plants.

Hopefully the scientific community can come to some sort of agreement on recommendations, and if not total agreement, at least general directions. I fought on the floor of the House to maintain the inspection and maintenance standards for individual States and for the Federal Government, and it was only by bringing together a coalition of the auto industry and State governments and environmentalists that we were able to succeed.

What I would recommend to all of you, as scientists, is that you figure out what coalitions you will be comfortable with and build enough of an influential body to persuade the other Members of this House who don't have the benefit or are not interested in the scientific facts, to make the right decisions for all the people. That is my message to you.

Now I have a question that I would like to ask. A number of you had mentioned that research is tremendously underfunded. You have also mentioned that there are at least seven or eight different areas where research must continue, whether it be total chemistry of rain or the long-term monitoring effects and the whole long-term whole ecosystem research and also regional research.

Sitting on this committee, I am quite aware how the budgets have been cut for research and development. I am also quite aware that the national acid precipitation asessment plan does exist that Dr. Cowling is working on. I'm also aware that Dr. Brocksen has been very successful in putting together a research pilot project in the Adirondacks. I'm very much concerned with the limited amount of dollars that are being expended by the various Federal agencies and the limited number of dollars that will be going for research to universities.

Is there some way we can consolidate the research that is going on, starting nationwide before we go global, to make sure that all of you have the opportunity to come together to compare notes and bring recommendations forward?

I know that this is your charge, Dr. Cowling, but I would like an answer from you as to whether you feel that you have been successful with this umbrella and whether you are in a position to collectively respond to all of the different concerns of the scientists that you are gathered with today.

Dr. COWLING. There are two separate programs, so let me distinguish between the national atmospheric deposition program which I serve as chairman. I'm not directly involved in the national acid precipitation assessment program, except as an enthusiastic supporter.

The NADP is centered in agriculture but involves numerous other Federal agencies. NADP responds to needs for monitoring information and a certain amount of effects research.

The NAPAP is a collection of all Federal agencies involved in acid rain research. Dr. Claire Harris from the USDA is here today and Dr. Jack Pickering from the U.S. Geological Survey; they are responsible for certain research going on in their respective agencies.

I would certainly encourage the Congress to take an active interest in the NAPAP program of research and insure that adequate funding is provided within those individual agency budgets. And I would like to suggest further that taking an active interest in the agencies' budgets and asking each of those agencies to do its part in relation to its particular expertise would be a finer way to proceed, in my judgment, than providing central funding for this kind of effort.

The expertise with which to deal with acid precipitation in all of its biological and all of its atmospheric and all of its sociological and economic implications, as you properly emphasized today, requires all of the agencies to play an effective role in the area of their maximum inherent comparative advantage; that is, spreading the funding through all of the agencies and holding each of the agencies responsible for doing their share to make sure that the national program is successful.

Mrs. **Schneider**. Do you think at this time there's adequate integration of the academic community into the agency programs?

Dr. **Cowling**. I think we might invite others to respond to this question. My answer would be "No." I think the national acid precipitation assessment program is thought of as a Federal program, and certain amounts of funding, of course, are passed on into university systems. But I think there is a substantial amount of, as yet, underutilized university talent that could be tapped by placing more of the total resources in the hands of university scientists than is now occuring.

Mrs. **Schneider**. Dr. Loucks?

Dr. **Loucks**. I would like to expand on the question of why we don't know more about benefits, by saying it is 2 years this fall since Dr. Cowling and I and others first documented the need for monitoring of the effects—the fisheries and the associated lake chemistry. There is still no such monitoring program.

We have observations at a few sites. Thus even though we have seen a 10-percent decrease in sulfur emissions, and at one location an indication of perhaps 10- to 20-percent decrease in deposition, the only location where we have a record of a trend in benefits from decreased deposition is in Nova Scotia where there is evidence of improvement in the rivers. We don't have evidence anywhere else because we haven't looked. We don't have a monitoring program.

The monitoring of effects is very complex because these resources are largely the responsibility of the States. It is extremely difficult to ask a Federal agency to mount a monitoring of fishery effects when the resources are not their responsibility.

I don't know how you solve that, but it is very difficult to ask us——

Mrs. **Schneider**. That was my next question.

Dr. **Loucks**. Why don't we have a record of prospective benefits, when, although we anticipated the need to answer that question some 2 years ago, we have made no progress, in my judgment, toward assembling that information base.

Mrs. **Schneider**. Dr. Husar?

Dr. **Husar**. This is to give you at least my assurance that many of us have been thinking over these past years about the cost-benefit analysis. It was only our preoccupation with the scientific component of that question that has prevented us from actually doing something more on that.

But I feel strongly that our scientific understanding has, in fact, been advancing over this past decade sufficiently that we can, in fact, now leave our nitty-gritty, nuts-and-bolts questions and address the larger component; that is, the entire systems behavior.

I think one key question on that cost-benefit analysis is whether or not reducing emissions will near linearly reduce the deposition. I feel that the complex problem of the acid rain has been unnecessarily overcomplicated, because beyond doubt, whatever sulfur and nitrogen compounds you emit will come down in exactly the same amounts. Hence, there is no particular reason to believe that there is any significant nonlinearity.

Second, to the point of cost-benefit analysis, I feel—and other members of this panel have voiced this opinion—that we are too much concerned with acid rain. It is not acid rain. It is dirty air that we are concerned with. The entire set of pollutants that we have to consider. It's not just the lakes that we would want to include in the cost-benefit analysis, but all the effects, including those that are much easier to handle, such as the materials damage.

The national corrosion cost is estimated to be about 5 percent of the gross national product. A fraction of that is due to atmospheric corrosion and deterioration of materials. Such estimates have been done at least for the past century. If we could now redirect—and we would appreciate encouragement from you—our attention more toward cost-benefit analyses, I feel if we concentrate on that in years to come, I believe that the university community and others will be capable of coming up with rational suggestions on control options.

Mrs. **Schneider**. Yes?

Dr. **Mohnen**. I would like to address your first question on the research programs. I think that the Congressional Research Service will be quite happy to supply you with a detailed history of the climatic impact assessment program [CIAP]. This was initiated several years ago in order to respond to very specific questions that scientists have raised and that Congress has taken up in regard to high-altitude aircraft. It was, in my opinion, one of the best programs that made atmospheric sciences history.

I believe that a similar program should be initiated that could aid atmospheric science together with other similar programs in the aquatic/terrestrial field in answering the questions you have. In the climate impact area, a clear time limit was set; a clear set of questions was given to the community, and a definite science management approach was taken. This still awaits realization.

No. 2, to your question about actions, certainly you always hear people talking about "reducing, reducing, reducing." You heard unanimous testimony, I believe, from the panel that all pollutants in the atmosphere act simultaneously. I'm inclined to say "act in harmony to create disharmony in the ecosystem and in the environment."

You heard before that New England has reduced their sulfur dioxide emissions by 40 percent through nuclear energy conservation, and other efforts. This is commendable. But at the same time, we now see increase in the burning of wood that for all practical purposes, will have a similar detrimental effect on the environment.

Now this is the kind of offset that occurs. You show somewhere the reduction of one pollutant, and at the same time you neglect other parameters that can do similar damage. That, again, involves an integrated approach. It involves a vision that is broader and beyond the control of one single parameter. And in that context I would like to give my advice to Congress, to have that broad vision and not single out one single parameter and be happy and assume that now you have achieved your goal.

Mrs. **SCHNEIDER**. Thank you very much.

Mr. **SHAMANSKY**. Would the Congresswoman yield?

Mrs. **SCHNEIDER**. Yes, I'd be happy to yield.

Mr. **SHAMANSKY**. Your chart is extremely interesting to me because I'm from Columbus, Ohio, and we have more—we produce—I'm not saying proudly, as a matter of fact—according to your chart maybe double what any other State has shown to produce in the way of sulfur dioxide emissions. With a commendable decrease of 18 percent, we are still producing over 2 million tons a year.

Ohio has a great deal of high sulfur coal which could make—which could provide fuel if we knew how to use it properly.

My question to the panel is, are we—can we by coal washing—we have a very enthusiastic Governor who in the past denied we produced any such kind of rain or atmospherics, and now he says we'll wash all the coal. That may be a very good idea.

One, would it help, regardless of getting rid of the deposits? We have to do something. But if we could, can we control that? Would washing the coal help? And two, what do you see, if anything, with respect to fluidized bed, the burning of high sulfur coal?

These are important questions to our State. We have the energy, if we can just utilize it in a healthful way.

Dr. **HIDY**. In answer to your question, sure it will help. Coal washing, I believe, takes out 25 to 50 percent of the available sulfur in the coal. So that is a definite step forward.

As to fluidized bed combustion, I'm not qualified to answer that question. But there is a parallel issue associated with proceeding with gasification and liquefaction technology which seems to have been slowed down somewhat in the last year or so, because of other priorities.

Dr. **MOHNEN**. I would like to make a quick response to that. I would like to remind the panel that a considerable amount of high-sulfur coal mined in the Midwestern States is already being washed. This is the first step and should be recognized as such. We're talking about the advanced coal wash that will give additional reduction.

But it should be said in all fairness that coal is already being washed in this country. Most major companies already have installed facilities to do so. It is the many, many small operators that do not have the necessary capital to do the coal wash job.

Mr. **SHAMANSKY**. Did you look into the question as to whether or not there is an economic way of bringing them within the coal washing program?

Dr. **MOHNEN**. I would have to refer you to the EPA report that addresses those questions. I have it with me, and I can leave it here.

Mr. **SHAMANSKY**. Thank you.

Mr. **SCHEUER**. On that point, we have been told that coal washing very substantially increases the efficiency of the plant from the point of view of energy production and that it has real payoffs to the company in more efficient production management, completely apart from its polluting effects.

Is this true? Does coal washing improve the efficiency of the coal burning process in the conversion of coal to energy?

Dr. **MOHNEN**. I think I should again refer this question to the technocrats.

Dr. **BROCKSEN**. May I respond, Mr. Chairman, not to your question but to the Congressman's?

Once again, I don't think there's anybody on this panel that can qualify as a control technologist or a specialist. But I would refer you to the fact that in the Electric Power Research Institute alone, annually we are committing somewhere around $75 to $80 million to research on control strategies, and they have just begun funding a new coal cleaning facility at Homer, Pa., and I would suggest that since it is indeed a serious consideration of yours and will impact on your decisions, you should have the appropriate people to discuss these issues with.

Mr. **SHAMANSKY**. What has your experience been so far. If you're spending that kind of money annually, what can you tell us?

Dr. **BROCKSEN**. You see, I can't tell you anything because that's a whole different division. But I'm encouraging you to talk to the people, and I would certainly commit myself to supplying the names that would be appropriate.

Mr. **SHAMANSKY**. American Electric Power is now establishing itself in Columbus, and I'm sure they would be very much interested, as all of us would be to encourage the most efficient use, the most healthful use of an important resource.

In Ohio, we produce twice as much as any other State shown here. I don't say that proudly. It's a real concern. But we've got that energy there, if we can just use it.

Dr. **BROCKSEN**. I agree with you, sir, and I refer you specifically to Dr. Kurt Yeager, who is director of the Coal Combustion Systems Division at the Electric Power Research Institute. I'm sure he'll give you a spectrum of experts in the field to visit with.

Mrs. **SCHNEIDER**. I would like to pick up on one of the final points I raised. That was the broad spectrum of areas that each of you have indicated it's necessary to delve into insofar as research is concerned. And recognizing that the research budget in your areas has already been cut this year, I will tell you that after the first of the year, we will be asked to cut the budget again substantially.

Now in order to make our job more professional, I personally and I'm sure this committee would like to have the benefit of specific recommendations insofar as costs that are necessary in order to fulfill your whole program, half of your program, and some creative thinking as to how there might be some sharing of costs or whatever.

But this is of critical concern to me because I am aware that we will be asked to cut more.

Dr. LOUCKS. If I could respond to that, let me say all of us are very impressed with the quality of the program Dr. Brocksen at EPRI has developed for the Adirondacks, and we keep asking the question, can the Government agencies assemble a program of equal effectiveness at several other locations.

I think, it is possible for the Government to run such a program at the same comparative cost-effectiveness as theirs. It is $1½ million a year, Dr. Brocksen, is it not? Perhaps we are talking about two or three other locations to accomplish the assembling of a data base for the dose/response relationships such as we described earlier. That is much less than is being proposed in the national plan now being implemented, but it would require a great deal of bending and careful management of the acid rain research being undertaken now among the agencies. The agency initiatives would require fine-tuning to a degree that we have not seen previously in a multiagency managed program.

Surely, it is possible to achieve such coordination if that kind of budget cut is required.

Mrs. SCHNEIDER. Thank you very much. Yes?

Dr. MOHNEN. I think it would be worth your while if your staff discusses this issue with Dr. Chris Bernabo from the Council on Environmental Quality, who has put together an acid rain assessment plan, about his input on where to cut if that would be most vital to all of us on the panel.

Mrs. SCHNEIDER. All of you are familiar with it and are in support of it?

Dr. MOHNEN. I can only speak for myself. I have discussed it.

Dr. JACOBSON. Mr. Chairman, may I make a comment concerning the dollars spent on research?

Mr. SCHEUER. By all means.

Dr. JACOBSON. There's a philosophical question of how one establishes the amount of money that should go for research on a subject of this sort. There are different ways of considering that question.

One way, that I don't think has been considered very much, is how much money would be spent for control and what is the relationship of the amount of money spent for research in relation to what we might spend for controls, without a real understanding of whether those controls are needed. The amount spent for research, is in a way, a need in order to prevent excessive spending, unnecessary spending for controls, as the chairman indicated previously. So I wonder if one were to look at that relationship—that is, the relationship between the dollars needed for research on acid rain and what might be spent for control of sulfur dioxide emissions that perhaps might not be necessary—and I think you will find that there is a very, very wide disparity between those two numbers.

The other traditional way of looking at it that is to look at the costs and benefits. I might point out to the members of your committee that there is one attempt, as far as I know, to determine the costs and benefits of sulfur oxide control, and this has been done not in the United States but for Western Europe by OECD. And it might be of interest to you to see a copy of this and get some of the flavor of the complexities involved in trying to establish the costs and benefits of even the relatively limited question of——

Mrs. SCHNEIDER. I think all of us recognize that the problem is, that we're being asked to make definitive answers or provide solutions, whether it be in regulatory reform or determining how many dollars should be spent. And we know that it's complex. But people who might oppose us will provide very simple, emotional, persuasive answers.

My only point is that we have to have more appropriate conclusions ourselves. I know that science is an ever-moving, integrated study. But we have to move beyond that and make decisions, and that is the difficult part when serving on a Science and Technology Committee.

Dr. BROCKSEN. May I respond, Mr. Chairman, very briefly?

Mr. SCHEUER. Yes. And then after that, I want to move to the other subcommittee member, Congressman Sensenbrenner.

Dr. BROCKSEN. I would just keep in mind, if I were you, that this was not a directive—that we were asked to meet yesterday to discuss the state of the science and what we felt should be done, where we're at, if we can give you anything definitive.

We feel we have given you as much as we can. If you are dissatisfied with that, then don't cut our budgets anymore.

Mrs. SCHNEIDER. Well, I must say that we are not dissatisfied with the information that you have provided us with. It certainly has provided us with a greater understanding of the research and the complexities of the problem.

But I think it's important that all of you understand that our job is to solve those problems. And as you tell us, there are no easy answers. We know that, yet we've got to come up with one. If we don't come up with the right one, then, you know, we are not looking out for the best interests of our constituents.

Mr. SCHEUER. I also must confess to a sense of frustration that we aren't really making visible progress toward meeting our responsibility to determine how much research and what kind of research are needed to achieve results that would factor into the Clean Air Act, which is the decisionmaking arena that we are going to be entering in another couple of months.

Now, it may be beyond the capability of scientists like yourself to help us more specifically than you have. But I have an abiding sense of frustration and maybe it's due to my own inadequacy, that I don't have a grip on how much research and what kind of research we should be funding, to give us information on the appropriate and reasonable reductions in permissible levels of sulfur dioxide that would make sense for the Congress to impose on industry, with the multibillion-dollar price tag that will be attached to them.

It may be that this panel can not do that. But this is what we are probing for. I am somewhat frustrated.

Congressman Sensenbrenner, a member of the subcommittee.

Mr. SENSENBRENNER. Thank you very much, Mr. Chairman.

I would like to express again the frustration that I believe all of my colleagues on the subcommittee have expressed, that it really is very difficult to find out in what direction we should be going.

As Members of Congress, I think that there are really two questions that we have got to find a legislative answer to within the next several months.

The first question has just been alluded to by the chairman, and that is: How we should allocate the research funding that will be available for fiscal year 1983 and subsequent fiscal years? That is a judgment call and I think that Congress probably has a little more flexibility in making the decision, as well as a little bit more patience on the part of the administration and the public, should we misallocate the dollars and make a mistake.

The second issue is a little bit stickier, and that is: What amendments to the Clean Air Act are necessary to get a handle on the problem of acid precipitation? And there, I don't think we have the flexibility and the patience, because this is a Congress that is a deregulating Congress. It is a Congress that will be relaxing Federal regulations on many segments of our economy. And in terms of getting a handle on the acid precipitation problem, I think that the consensus is there will have to be decreased regulation.

So, really there is going to have to be a very clear cost-benefit analysis that is presented to our colleagues in the House of Representatives, if we wish to accomplish increased regulation in curtailing sulfur dioxide or nitrogen oxide emissions.

I think what we are looking for, from the scientific community, is some kind of a clear answer that we can present to our colleagues in the House of Representatives, and survive the debate on cost-benefit analysis, as well as the natural political desire to dump someone's garbage in someone else's backyard.

I guess I am at somewhat of a disadvantage, because I don't have a scientific background. I'm just a poor country lawyer that got elected to Congress. But one thing that I have concluded, based upon my participation in these acid rain hearings and acid precipitation hearings, is that the scientific community is just like a bunch of Congressmen getting together: Nobody can agree on anything and where to go.

But at least in terms of the rewrite of the Clean Air Act that will be coming before the House early next year, we've got to get to a consensus, and fast. I don't know how we get there, and from what I've heard from you this morning, I don't think you do either.

Dr. JACOBSON. Mr. Sensenbrenner, I would like to make a comment.

You referred to regulation. Other Congressmen have referred to regulation. And yet, one of the interesting changes in this country has been a subtle shift away from regulations and toward encouragement and stimulation of cleaner, less polluting sources. There has been a determined effort to try to use the marketplace to stimulate the use of cleaner and more efficient systems.

And personally—not speaking for the panel or anyone else—I would encourage you and others to consider more intensive use of one or more of these mechanisms for encouraging the utilization of cleaner combustion facilities, as opposed to the regulatory approach, which has proved so difficult and so complex.

Dr. **Hidy**. I would like to second that.

I really hope that whatever Congress does, that they consider all possible routes toward a solution which will provide for greater industrial efficiency. From our viewpoint as consultants we receive from our industrial sponsors a continuing feeling of their frustration of the uncertainty of the times. Industry does not know from a cash flow point of view what to expect from year to year in terms of new regulations. They cannot plan objectively to make their investments in a responsible way, for their industry in a climate capicious to regulatory change.

So, anything that Congress can do to reduce this trauma, providing a positive incentive for early phase-out of older plants, to modernize our industry and increase the strength of our own industry domestically will place us far ahead of our current situation.

Mr. **Sensenbrenner**. Again, that's easier said than done, because at our Lake Placid hearing, we got statistics that the cost of electricity per thousand kilowatts was one-third the cost of New York City, in the Cincinnati electric utility. And that's in an area that is suspected to be causing most of the problem.

Now, really, the only way that we can require the Ohio Valley utilities to clean up their act is through some kind of regulation, either on ambient air quality, as the Clean Air Act standards have been set, or through some other standard on what goes into the electric generating process.

There is a provision in the new tax bill, as Members of Congress know, that do allow electric utilities to offer a tax-free dividend reinvestment plan for newly issued stock as a way to get electric utilities out of having to borrow huge amounts of money at outrageous interest rates, in order to build new electric powerplants. And this is hoped to be somewhat of a way of shifting the cost of these new plants from debt financing to equity financing. And equity financing always costs less than debt financing.

So that perhaps is a step in the right direction, but that doesn't get us past the immediate problem of what we in Congress do when the Clean Air Act reauthorization comes up next year. And I don't think that any of the members of this subcommittee have got any real answer that we can take over to the floor and get chopped apart and survive a vote on the House floor.

Dr. **Loucks**. I would like to comment on the earlier part of your question, Congressman Sensenbrenner, having to do with the role of the research that is still needed in relation to the decision process that you face this winter.

I would like to point out that in the United States-Canada assessment underway right now, we have determined by a preliminary model that a no-effect level is probably at 25 percent of the present acid rain input. In other words, one would have to talk in terms of a 75-percent decrease, to reach a no-effect level. Of course, it's very improbable that we are going to do that very soon.

However, one can also think of the 75-percent range as something that might be attacked incrementally, in three parts, let us say. I like to use the analogy of someone with a severe cold, who has three long-term cold pills that they take for relief, but they are a little concerned about the side effects of taking each one of them.

We might have relatively little difficulty and only mild uncertainty about taking the first one; that might be a 20- or 25-percent reduction in this case. However, we have more uncertainty about taking the second one, and we would like to fine-tune the cost-benefit relationship carefully before we go into taking the third one.

This is how we have to understand the decision process now. There is, in my judgment, substantial evidence the benefits that would accrue from taking a first step are justified in relation to the associated costs. However, we must have the kind of research program that has been discussed in our meeting yesterday, and presented here this morning, before we make the decision on whether any abatement program further than the first 25 percent will be warranted.

Indeed, there is a major advantage to having the benefit of evaluating effects from taking that first pill over at least a decade. It will take 10 years before we can accomplish much in the way of abatement, because I don't think any of us want to see it happen precipitously, such that money is thrown away on a poor investment in appropriate scrubbing technology.

Mr. **Sensenbrenner**. We weigh that more than you, because we have to justify Federal expenditures to our constituents. You know, the only fair tax is one that somebody else pays.

Dr. **Loucks**. Being from Indiana, I'm very much concerned with the coal industry in Indiana. There are some very, very complex tradeoffs, and the thought of bringing western coal to fire Indiana burners is politically explosive in our State.

Mr. **Sensenbrenner**. Let me say I'm not as pessimistic as Representative Schneider is on cut-backs in acid rain research, because all that I have heard in the decisionmaking process in OMB—which admittedly is somewhat more cloudy since the publication of the Atlantic Monthly article—is that acid rain research funds will actually be increased, although marginally, at a time when practically everything else is being cut.

I also think that recent political developments in Canada are going to make it more difficult for the Canadian Federal Government to actually do something concrete in this area, because my reading of the constitutional resolve that was announced between the Federal Government and all of the provinces and Quebec is that it will basically allow the Federal Government to take over few of the provincial functions, and environmental control is a present function of the provinces.

So, perhaps we will have to be dealing with 10 Canadian provinces rather than one Federal Government, in terms of the coordination of the research.

Mr. **Scheuer**. Dr. Mohnen?

Dr. **Mohnen**. You referred to us scientists here, that we, like you, are not fully aware of all the facts.

There is one basic difference, however. If we scientists make a mistake, our peers will laugh, and that's it. To paraphrase Will Rogers, if Congress makes a mistake, it becomes a law.

Mr. **Mitchell**. And our peers laugh all day long.

Mr. Scheuer. I will have to add the famous statement of Frank Lloyd Wright, the great American architect: That surgeons can bury their mistakes; we have to cover ours with ivy.

Dr. Mohnen. I do have something substantial to say, however.

The process that we all referred to continuously centers around the fact of starting with something that is least costly. Now, ultimately the question that we all must face is: Do we have the luxury of time with us? We really did not address that to any full extent yesterday. But if indeed it would turn out, as some scientists begin to see, that we have a few years' time, then the process that we try to suggest to you would be a very valuable one.

Do not try to regulate action that you see will come to pass 10 years from now; but do regulate something, or advise on something, that can come true in 2 years, and let science do its due process in assessing appropriately the result of that action.

Mr. Scheuer. Dr. Mohnen, one question that constantly keeps arising up here is: During this timeframe that you're performing the research and aggregating your data base that will justify us to make further incremental advances in the regulatory process, how much do we lose in the way of resources, and can we afford that?

Dr. Mohnen. I think that question was slightly addressed yesterday, but I certainly am not in a position to answer in the presence of the eminent experts here. So maybe they will try to volunteer.

The question that I personally have as an atmospheric scientist is this: If I suggest programs, do I see the end of the program before the effect has already taken place?

Now, for atmospheric sciences, deposition means we see something happening soon. As far as ecology is concerned, obviously it takes a tree 30 years to grow, and the time span is longer. But I believe what I have heard from my colleagues—that a 5-year timeframe is affordable.

Mr. Scheuer. Dr. Husar, then I'm going to call on Congressman Mitchell.

Dr. Husar. It is understanding, based on the historical trend of energy consumption—specifically coal consumption in the northeastern part of this country—that in the timespan between 1910 and 1920, as well as later on in the 1940's, we had coal consumption of about 600 million tons per year, which was about the same as that in 1975.

This, in my judgment, corresponds to about constant emissions SO_2 during the past 50 or 70 years. It is, therefore, my judgment that the ecosystem of the northeast—has been exposed to this kind of sulfur deposition for over the past 50 to 70 years and therefore, those ecosystems that have survived will be surviving over this next 5 or 10 years. A number of us here in the panel believe that that 10 years is the necessary timeframe for us to come up with rational suggestions for major controls.

But we also seem to have an agreement that there is time to make the first easy step, the least costly approach now, and then proceed with the higher-cost approaches at later times.

Mr. Scheuer. Thank you.

Congressman Don Mitchell from New York?

Mr. Mitchell. I'm greatly concerned that our scientists will be studying the problem to death while the lakes still continue to die.

I represent a part of the Adirondacks. And I would like to know a lot more about the urgency of the problem. Dr. Loucks stated that it would take something like 10 years to provide any significant relief or any significant abatement.

How urgent is the problem in the Adirondacks? The people that talk to me say that we have lost, I think, almost 300 lakes and they have only studied a little over 800. But they estimate that if they study all 3,000 they are going to find that 20 percent of them are dead and it is rapidly taking place. The people from Canada say this. They make very alarming statements.

How urgent is the problem in the Adirondacks?

Dr. **Loucks**. Congressman Mitchell, if I could clarify the paraphrasing that you make. With respect to the 10-year factor, I was saying that there is, in my judgment, substantial evidence of benefits that could be derived very quickly from an abatement that we might begin to implement now.

I say this partly because we have the evidence from Nova Scotia that acidity is being alleviated there, and that it appears to be traceable to the reduction in sulfur oxides in the Northeast. Work is going on in our laboratory indicating the mechanisms that are involved and give us reasons to believe that improvement in lake chemistry will be seen relatively quickly.

However, the reason I talked in terms of 10 years is because answering the very complex questions inherent in finetuning the cost and benefit estimates for a major abatement—50 percent or more—will take that long. Therefore, we need to see the results of the first—25 percent—step toward abatement.

Mr. **Mitchell**. Like priming a pump sort of, a classic example of what good we can accomplish.

Mr. **Loucks**. Like priming a pump which we have to put in motion now if we are to be able to study the kinds of benefits which some of us anticipate.

I don't know that all of the panel would agree that there are going to be benefits from a first step.

Mr. **Mitchell**. Suppose the Adirondacks were your property and you were a wealthy dictator, on the basis of what you know now, what would you do now to protect it, to save it?

Wealthy dictator, the Adirondacks is yours, you want to keep it healthy. You love it. On the basis of scientific information today, what would you do to do your best? Money isn't a problem.

Dr. **Brocksen**. I think I would be as perplexed——

Mr. **Carney**. Build a dome. [Laughter]

Dr. **Brocksen**. There you go.

They have alluded to a study that EPRI has in the Adirondacks. If you will accept some detailed study on three watersheds only containing three lakes——

Mr. **Mitchell**. Which three are you studying, Doctor?

Dr. **Brocksen**. Woods, Panther, and Sagamore.

Woods is acidic from the paleo-limnology records of the sediments, if you would accept that methodology. It has been acidic about 150 years.

Sagamore, which fluctuates.

And Panther is more or less neutral.

They all receive the same atmospheric inputs. However, the initial question is why? Why are those three lakes reacting differently to that atmospheric input?

Mr. **Mitchell**. Before you finish the answer, let me plug in another question that you can answer along with it.

The answer I've gotten to that in talking to people in the Adirondacks, is that different lakes have different ability to protect themselves, to leach out the acid. It depends on the rock formation. I think with a lot of limestone they can protect themselves. And most of the lakes in the Adirondacks apparently have a type of stone that does not permit this leaching.

Dr. **Brocksen**. I think if you look at the underlying bedrock geology alone you will come to that conclusion. But the soil till, the depth of it, and the type of vegetation are all going to impact the buffering capacity of those systems.

I think what Dr. Loucks is saying, and I believe most of the panel would concur, is that our research today, even the surveys that have been conducted in the Adirondacks, have been fairly superficial. And we are really just beginning to analyze the results of 500,000 data points in the Adirondacks.

Mr. **Mitchell**. In other words, the studies we are referring to with so many lakes dead, may well not be valid?

Dr. **Brocksen**. They may be valid. How long they have been dead and from what source is debatable. But, let me say this, sir. We have been studying that Adirondacks set of lakes, only 3 of them, for 3 years. And we have not seen an appreciable change in the acidity of those 2 that are not acidic, nor have we seen an appreciable change in that 1 that is acidic. And that is a sample size of 3 out of 2,700. That is not much. We are expanding it.

Mr. **Mitchell**. The method of study is terribly important, too and when you study. I understand there is a great increase of acidity with the spring runoff, or after a very heavy rain. And from the information I have gathered, a lake can be on the verge of being too acid—still supporting fish life but can have a terribly large increase during spring runoff and kill much of the fish life during just that period.

Is that possible?

Dr. **Brocksen**. I think that's possible as a hypotheses. I don't know that any such cases have been documented. But spring runoff has been documented in all three of our lakes, and the recovery from that big dip in pH has been documented. I think of greater concern is the mobilization of aluminum in those lakes during that period and the form that that aluminum takes in terms of being detrimental to the fish.

Mr. **Mitchell**. So what would you do as a dictator, Doctor?

Dr. **Brocksen**. Well, I'd probably find another kingdom. [Laughter.]

Mr. **Mitchell**. That's a nonanswer. You have got to do better.

Anyone else want to be a dictator and help save the Adirondacks?

Mr. **Jacobson**. Well, I wonder if it might be relevant to mention very quickly the experience in Great Britain. They had very serious smog problems, and they could have taken the tack of saying, well, let's really understand carefully which components in the atmosphere have specifically caused the effects that we have seen. Let's really understand what proportion of deaths that occurred in these episodes were really due to the atmosphere, and which proportion were due to natural or other causes. Let's understand the relationship between the emissions of particulate matter from combustion and the occurrence of these individual events. And let's finally, really know what the cost-benefit relationships are, so that the steps we take will, indeed, be effective.

They didn't take any of those steps. They went ahead and controlled particulate matter without the kinds of evidence that we now are requiring in order to control our air pollution problems.

And after a decade or two, it was seen that these control measures were, indeed, effective, and they aren't going back and reanalyzing to decide whether the costs were worthwhile.

Now, we are taking a very different tack and it is understandable that, as I was told by a British scientist recently, if that were to happen in today's economic climate, they probably would have made a different decision.

But basically, that is the situation you are faced with. You are faced with a difficult problem of having to make decisions, policy decisions in the absence of the critical information that you need. And there is no question how difficult it is, there is no question how courageous you will have to be in order to make these decisions.

Dr. MOHNEN. I would like to take advantage of your offer to be a dictator for just 30 seconds, and I am quite sure after I volunteer my opinion I will greatly regret ever having mentioned it.

However, from a different point of view we approached the acidity problem in the Adirondacks. I personally flew an airplane with my cloud collection system and rain collection system over the Adirondacks.

The hypothesis that I followed was that we have overcontrolled our particulate emission sources to the degree where the very, very small particles—the few grams that escape these modern collection systems—are not sufficient to neutralize the clouds and rains in the Adirondacks.

I submit to you the first evidence of that type showing very clearly that the rain in the Adirondack Mountains, and the clouds are having a pH of 3.6 on this particular day, while at the same time similar clouds from the same weather system had a pH of 5.5 downwind of major cities such as Buffalo.

The reason for that could be traced to the lime used in foundries in Buffalo that are still uncontrolled. The calcium, magnesium, and potassium content of those clouds downwind of Buffalo were 20 times higher than those of Adirondack clouds: calcium, magnesium, and potassium neutralized the clouds and rendered them "harmless."

Now, just to continue my role as a dictator, I would very carefully and very selectively make a source inventory of possible emissions in the State of New York or upwind of the Adirondacks. And I would find out to what degree, where, when, and how there are calcium emissions not related to sulfur—just those subelements that are considered beneficial, such as from cement industries. The particle emission thus providing those standards for those selected sources will be relaxed, more calcium, etc. from the air to reach sensitive regions and be deposited there.

Now that I have said it, I probably will soon regret it, but I think this offers a totally different philosophy on alleviating a very specific problem in the Adirondacks, where in my opinion a considerable impact comes from clouds, not just rain. So, if those clouds can have more neutralizing agents that are not detrimental to the system—calcium and magnesium without more sulfate and without more hydrogen ions—we will take a step forward.

Mr. MITCHELL. You are a scientific dictator, along with being a wealthy one, and you are recommending more studies again, and no action as far as actually doing something today to curtain pollution.

You are talking about finding new sources and checking the beneficial aspects of some pollutants.

But wouldn't you, if you had lots of money, wouldn't you like to do something concrete to decrease the amount of pollution, maybe all over New York State?

Dr. MOHNEN. Concrete, yes. There is no question whatsoever among this panel, among scientists in general, that what goes up has to come down. So, obviously, if we cut by 100 percent, we have cut depositions by 100 percent, that is obvious. If we cut by 50 percent then we are not sure where the beneficial effects will show up first. And it is right in this area where we don't want to mislead you—or at least I don't want to mislead you—in promising a significant or measurable reduction for a tremendous, very courageous move that you are going to make by cutting down emissions at very significant costs.

Mr. SCHEUER. May I say that there is no feeling up here that we are being "misled." If there is any frustration, it is that we are being "unled."

Congressman Mitchell?

Mr. MITCHELL. Just one last comment. Everyone does agree that the tons of pollution being emitted into the atmosphere and dumped, is not a great idea. We should certainly curtail as much pollution as we can all over. That's a generalization we all agree with, I guess.

If the scrubbers were installed in all coal burning plants old and new, sulfuric acid effluents would certainly decrease markedly, and we all agree on that.

If every coal burning plant had scrubbers, we'd have a lot less sulfuric acid in our Adirondack lakes and all over.

Can we agree on that point, too?

Thank you, Mr. Chairman. Thank you, gentlemen, too. I appreciate the fact that as scientists you have studied long and hard to develop areas of great expertise, and we realize the many ramifications of the problem—the great complexities that exist. I sympathize with that situation and I wish you luck in addressing it.

Two or three committee members have alluded to our dilemma in needing a few good one-liners in the debate situation. So, if you can help our communication process by giving us succinct, brief, definite statements of what you really do know—not all of the things we would like to know over a long period of years, but what you do know, that would help us in a debate. We would be deeply appreciative, because we don't have time to evaluate lengthy, scientific dissertations from experts. Members are going to listen to people debating on the floor that don't really know much more about the situation, or didn't know much more about the situation than the Members did a few months earlier. So, we are terribly dependent on you for good information contained in small packages.

Thank you, Mr. Chairman.

Mr. SCHEUER. Congressman Carney?

Mr. CARNEY. Thank you very much, Mr. Chairman.

We are in the process now of having to vote. My calendar will not allow me to come back again, and I would just simply like to say that as frustrated as you are as scientists in trying to answer the questions involved with acid precipitation, we as legislators have that same frustration in trying to answer the policy questions that we would have to implement.

That frustration has been eased somewhat with the hearings that we have had. In some areas it might have been increased. However, I feel that in the last 6 months under the leadership of the chairman, the cooperation of many of you who have testified before this panel on several occasions, our knowledge has increased. And I think we can look forward to some type of common ground that this Congress will find to try to address the question.

I thank you again for coming. I am sure that we will continue this contact. It is vitally important in our pursuit to provide the American people with a Clean Air Act that is acceptable and workable, and I thank you again.

In concluding, I would just like to tell Dr. Likens that I have asked the staff here to provide you with the record from the last hearing, at your request of the other night.

I would like to thank Dr. Jacobson for not giving any "on the other hands," today. [Laughter.]

Dr. JACOBSON. Mr. Chairman, could I make one final comment?

Mr. SCHEUER. Surely.

Dr. JACOBSON. I would like to thank the Congressmen, and particularly yourself, for providing these opportunities for scientists to get together with Congressmen, because it is extremely important that we understand what you need to know and the form in which you need to know it, so that we can go out and do a better job in our research.

Mr. SCHEUER. Well, it is kind of you to say that.

I want to express my thanks to all of you for having come from your busy pursuits, and having given us of your wisdom this morning, and also for the great work that you did all day yesterday. You really rendered a service above and beyond the call of duty, and we all appreciate it very much, being aware of your very heavy schedules and your important responsibilities.

I would also like to thank the staff people of the General Accounting Office, the Office of Technology Assessment, and the Congressional Research Service for their help. I don't know if any of you are here today, but we are very grateful for your help in putting this hearing together. We think it has been a very productive hearing; it has been what I hoped would be a sort of marketplace for ideas.

Let 1,000 flowers bloom, and we will all be better informed for it.

If we feel a little bit frustrated for the lack of specific answers and clear directions, forgive us, but that is our mandate here and we are cognizant of what a tremendously complicated subject matter we are dealing with. At least give us credit for being modest enough that we are very conscious that we need help.

So, with repeated thanks to all of you, and to the three agencies that I mentioned, the OTA, the GAO, and the CRS, we will declare this meeting adjourned.

[Whereupon, at 11:50 a.m. the hearing was adjourned.]

ACID RAIN

WEDNESDAY, DECEMBER 9, 1981

House of Representatives,
Committee on Science and Technology,
Subcommittee on Natural Resources,
Agriculture Research and Environment,
Washington, D.C.

The subcommittee met, pursuant to call, at 2:15 p.m., in room 2318, Rayburn House Office Building, Hon. James H. Scheuer presiding.

Mr. **Scheuer**. The subcommittee will come to order.

My colleague has a unanimous-consent request.

Mr. **Carney**. Thank you, Mr. Chairman.

I notice that we have electronic media in the audience. I would ask unanimous consent that this meeting can be recorded by audio and visual recording devices.

Mr. **Scheuer**. There being no objection, so ordered.

Today we open hearings on H.R. 4830, the Acid Rain Research Implementation Act of 1981, and H.R. 5055, the Acid Precipitation Accelerated Review and Reporting Act.

Acid rain is one of the most perplexing environmental dilemmas of the 1980's.

On the one hand, the costs of doing nothing to abate acid rain may lead to enormous costs. The cost to our deteriorating waters, lakes, rivers, streams, of our croplands, grasslands, of our forest products industries, to our buildings and structures and even to our health may be very substantial.

All the evidence is not in, but I think we have a consensus among the American people that we don't want to degrade our environment, we don't want to pass on a nation to our children and to our grandchildren that is environmentally degraded. We did not receive it that way and we don't propose to pass it on in a degraded fashion.

Most of us have a sense of pride and love of our country and its wonderful natural resources, its hills and mountains and streams and valleys, apart from cost-benefit analyses.

However, the other side of the equation is that we are in an economy and in a society that suffers under the sharp knowledge on the part of all of us that there is no free lunch and we have to operate under economic constraints.

We cannot be levying costs on industries that undoubtedly will be in the billions and billions of dollars without some kind of demonstrable evidence that we have a reasonable level of benefit.

Whatever level of environmental regulation this Congress mandates must be sensible and must be prudent and must therefore produce benefits that are clearly in excess of its costs.

I think the American public wants that. I think the election results 1 year ago had something to do with that signal, and I think there is quite a bipartisan agreement.

We don't want to do nothing. We probably can't afford to do everything, and the big questions that we have to decide are, What level of regulation does the present knowledge base that we have justify; what further research and development should we do; what should be the parameters of that research and development and over how long a timespan—3, 4, 5 years, perhaps—before we will have a knowledge base sufficient to justify us in going ahead with a second incremental level of regulations that would be justified by the additions to our current knowledge base.

I think that both of the bills that we are considering today are well-intentioned efforts to improve that data base. They are also aimed at reducing the timelag in the accumulation of hard scientific evidence.

As such, I am confident that the general approach taken by these bills is one that a great majority of our colleagues can and will support.

Our first witness will be our colleague on the Science and Technology Committee, Congressman Judd Gregg of New Hampshire, the sponsor of H.R. 4830 and a very diligent and knowledgeable voice in the House on the subject of acid rain. Following Congressman Gregg will be our colleague from West Virginia, Mr. Nick Rahall, the principal sponsor of H.R. 5055.

Before I yield to my distinguished colleague from New York and my distinguished colleague from Rhode Island, I would like to ask unanimous consent to place both of these bills, H.R. 4830 and H.R. 5055 in the record. There being no objection, it is so ordered.

[The bills follow:]

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97TH CONGRESS
1ST SESSION

H. R. 4830

To strengthen research and development programs aimed at understanding the causes and effects of acid precipitation, and to establish a process for cooperative decisionmaking on strategies to control this environmental problem.

IN THE HOUSE OF REPRESENTATIVES

OCTOBER 22, 1981

Mr. GREGG (for himself, Mr. SCHEUER, Mr. WALGREN, Mrs. SCHNEIDER, and Mr. CARNEY) introduced the following bill; which was referred jointly to the Committees on Science and Technology and Energy and Commerce

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A BILL

To strengthen research and development programs aimed at understanding the causes and effects of acid precipitation, and to establish a process for cooperative decisionmaking on strategies to control this environmental problem.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SHORT TITLE

SECTION 1. This Act may be cited as the "Acid Rain Research Implementation Act of 1981".

FINDINGS

SEC. 2. The Congress finds that—

(1) a lack of consistently analyzed data concerning the causes and effects of acid precipitation and long-range air pollutant transport and the most effective strategies to prevent, limit, and remedy the harmful effects of such phenomena is causing uncertainty and unnecessarily adversarial relationships among geographic, economic, and industrial sectors that are involved in such causes and effects;

(2) further clarification about ~~such~~ causes, effects, and most effective strategies would—

(A) reduce governmental and private spending by avoiding investments in unneeded or ineffective environmental control strategies, or nonviable energy, transportation, or industrial development patterns; and

(B) prevent costly and irreversible environmental damage caused by the failure to take effective and timely action to protect the environment from the harmful effects of acid precipitation;

(3) the ten-year national acid precipitation assessment plan and its cooperative links to similar State and international programs concerned with acid precipita-

tion provide an established framework for synthesizing existing and developing scientific data and for making recommendations for strategies to prevent, limit, and remedy the harmful effects of acid precipitation; and

(4) establishing within the framework of such plan specific interim points when cooperative assessments will be made by Federal, State, local, international, and private sector authorities will—

(A) eliminate delay in converting scientific findings into appropriate control strategies and regulations designed to prevent, limit, and remedy the harmful effects of acid precipitation;

(B) facilitate timely and cost-effective adjustments of energy, industrial, transportation, and environmental practices necessary to contribute to the elimination of acid precipitation; and

(C) minimize social dislocations and adverse and inequitable economic impacts caused by the imposition of unanticipated measures to prevent, limit, and remedy the harmful effects of acid precipitation or by the occurrence of environmental damage caused by acid precipitation.

DECLARATION OF PURPOSE AND POLICY

SEC. 3. The Congress declares that it is the purpose of this Act and the policy of the United States—

(1) to implement immediately a strategy to eliminate acid precipitation and to remedy its harmful effects;

(2) to accelerate the timely use of scientific data collected under the plan and to refine and improve control strategies on a continuing basis by providing adequate resources and coordination to the acid precipitation task force;

(3) to promote complementary and effective research programs and to avoid costly retrofit or dislocation caused by investment in ineffective or unnecessary alterations of industrial, energy, transportation, environmental, and emission control practices by strengthening efforts under the plan aimed at effecting cooperation and communication among Federal, State, local, and foreign governments, academic institutions, international organizations, and the private industrial sector with respect to—

(A) exchanging research information concerning acid precipitation on a systematic and timely basis; and

(B) monitoring the effects and long-range transport patterns of acid chemical compounds and other pollutants; and

(4) to develop, analyze, and recommend as part of such process—

(A) alternative control strategies to prevent, limit, and remedy the harmful effects of acid precipitation, including analyses as to the relative costs of such control strategies;

(B) methods for equitably raising the capital for, and sharing the costs of, the implementation of such control strategies; and

(C) other technical and institutional arrangements necessary for implementation of such control strategies and needed regulations.

DEFINITIONS

SEC. 4. For the purposes of this Act—

(1) the term "acid precipitation" means the wet or dry deposition from the atmosphere of acid chemical compounds;

(2) the terms "national acid precipitation assessment plan" and "plan" mean the comprehensive research plan prepared under section 704 of the Acid Precipitation Act of 1980 (42 U.S.C. 8903);

(3) the terms "acid precipitation task force" and "task force" mean the acid precipitation task force formed under section 703 of such Act (42 U.S.C. 8902); and

(4) the term "Administrator" means the Administrator of the Environmental Protection Agency.

RESPONSIBILITIES OF ADMINISTRATOR, SECRETARY OF AGRICULTURE, AND ADMINISTRATOR OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

SEC. 5. (a) As soon as practicable after the date of the enactment of this Act, the Administrator, the Secretary of Agriculture, and the Administrator of the National Oceanic and Atmospheric Administration shall meet and take such actions as are necessary to ensure that the plan is structured and supported in a manner that—

(1) satisfies the purpose and policy of this Act declared in section 3; and

(2) enables the Administrator to carry out subsections (b), (c), and (d).

(b) Not later than twelve months after the date of the enactment of this Act and not less than once every twenty-four months thereafter, the Administrator of NOAA, as director of task force research, will provide the Administrator with a report of the status of the research program of the task force. Within sixty days of receiving this report, the Administrator shall make a determination whether any new measures are necessary to prevent, limit, and remedy the harmful effects of acid precipitation and shall submit a report outlining such determination to the Congress and the President. Any finding or recommendation submitted to the Administrator by the task force in connection with such determination shall accompany such report. If the Administrator determines such measures are necessary, then the Administrator—

(1) shall, in such report, specify and make recommendations for legislative or administrative action concerning—

(A) measures that should be implemented in the short term for preventing, limiting, and remedying the harmful effects of acid precipitation based on the best available technical data and control strategies; and

(B) longer term, systemic measures (such as the adoption of the use of different energy sources, modification of transportation systems, and alteration of industrial development patterns) that would help prevent, limit, and remedy the harmful effects of acid precipitation; and

(2) not later than one hundred eighty days after submitting such report, shall issue proposed rules requiring measures to be taken that may help prevent, limit, and remedy the harmful effects of acid precipitation.

(c) To prepare reports and proposed rules required under subsection (b), the Administrator shall—

(1) contract with the National Academy of Science—

(A) to study and report to the Administrator and the Congress on the state of knowledge and the adequacy of research programs being carried out under the plan and elsewhere with regard to understanding and identifying the optimal strategies to prevent, limit, and remedy the harmful effects of acid precipitation; and

(B) to carry out independent analyses of, and report to the Administrator and the Congress on, alternative strategies for dealing with the harmful effects of acid precipitation that are receiving inadequate research attention, including research with respect to the effectiveness, degree of environmental protection, costs, feasibility, and timing of such alternative strategies;

(2) work with the task force, State, local, and foreign governments, and private industrial, environmental, scientific, and international organizations in establishing and strengthening monitoring networks to determine the sources and effects of acid precipitation and other long-range pollutants; and

(3) make arrangements (such as annual workshops, conferences, and data formatting agreements) with the entities specified in paragraph (2) for exchanging information and engaging in cooperative analysis of data concerning measures to prevent, limit, and remedy the harmful effects of acid precipitation to ensure that—

(A) such data are evaluated and utilized as rapidly as possible; and

(B) directly affected regions or economic sectors can plan and implement such measures in a cooperative fashion with other regions, other economic sectors, and governmental institutions with minimum economic and social dislocation and maximum protection of the environment.

(d) Working within the plan and in cooperation with other programs, the Administrator—

(1) shall ensure that adequate analysis and comparative consideration is given to institutional arrangements that may be necessary to implement the measures specified in reports submitted under subsection (b)(1), including approaches to cost sharing and capital formation to carry out such measures that will minimize unforeseen or inequitable economic impacts on particular regions or economic sectors;

(2) shall include in the annual report of the task force submitted under section 704(e) of the Acid Precipitation Act of 1980 (42 U.S.C. 8903(e)) a statement that contains a description of the actions taken under paragraph (1) and any recommendations for legislative or administrative action concerning such institutional arrangements.

(e) The Administrator, in consultation with the Secretary of Agriculture and the Administrator of the National Oceanic and Atmospheric Administration, shall prepare and include in the annual report referred to in subsection (d)(2) a statement concerning the adequacy of the resources available to the task force to carry out research, development, and monitoring activities necessary to achieve the purposes of this Act.

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97TH CONGRESS
1ST SESSION

H. R. 5055

To provide for an accelerated study of the causes and effects of acid rain, to provide for an examination of certain acid precursor control technologies, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

NOVEMBER 19, 1981

Mr. RAHALL (for himself, Mr. BLILEY, Mr. APPLEGATE, Mr. KOGOVSEK, Mr. MURPHY, Mr. PERKINS, Mr. BAILEY of Pennsylvania, Mr. SYNAR, Mr. DANIEL B. CRANE, Mr. YOUNG of Alaska, Mr. MOLLOHAN, and Mr. STATON of West Virginia) introduced the following bill; which was referred jointly to the Committees on Energy and Commerce and Science and Technology

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A BILL

To provide for an accelerated study of the causes and effects of acid rain, to provide for an examination of certain acid precursor control technologies, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Acid Precipitation Accelerated Review and Reporting Act".

FINDINGS AND PURPOSES

SEC. 2. (a) FINDINGS.—The Congress finds and declares that—

(1) the phenomenon known as acid deposition is a problem of both national and international scope and interest;

(2) acid deposition occurs in various parts of the world and has the potential to contribute to higher levels of acidity in aquatic systems, terrestrial systems, and the deterioration of buildings and monuments;

(3) acidity in precipitation occurs through both anthropogenic and natural causes;

(4) sulfur dioxide and nitrogen oxides from industrial and transportation sources have been identified as major contributing elements in the creation of acid precipitation;

(5) the atmospheric chemistry relating to the conversion of sulfur dioxide and nitrogen oxides into sulfates and nitrates is enormously complicated since the conversion can be influenced by temperature, sunlight, humidity, catalytic particles in the air, and the presence of certain oxidants;

(6) there is widespread agreement in the scientific community that the method by which the precursors to

acid precipitation are processed in the atmosphere is poorly understood;

(7) various techniques of reducing emissions from stationary sources of precursors of acid deposition, including increased use of precombustion fuel treatment and the development of inherently low-polluting combustion technologies, may prove to be of significant long-range value in reducing the amount of acid deposition;

(8) the national acid precipitation assessment plan established under title VII of the Energy Security Act, and its cooperative links to similar State and international programs concerned with acid deposition, provide an established framework for synthesizing existing scientific data, and developing additional scientific data, relating to acid deposition and for making recommendations for strategies to prevent, limit, and remedy the harmful effects of acid deposition; and

(9) the causes and effects of acid deposition, particularly the atmospheric chemistry and of long-range transport of acid deposition precursors, should be more fully understood before undertaking complex and potentially costly efforts to further control sulfur dioxide and nitrogen oxide emissions.

(b) PURPOSES.—It is the purpose of this Act to provide for—

(1) an accelerated effort to understand the causes and effects of acid precipitation; and

(2) examination of the potential and feasibility of various techniques of controlling sulfur dioxide and nitrogen oxide emission, such as precombustion fuel treatment and inherently low-polluting combustion technologies, which may hold promise of reducing emissions of these pollutants.

SEC. 3. (a)(1) Sections 704(a) and 704(d) of the Energy Security Act (Public Law 96–294) are amended by striking out "ten-year" and substituting "five-year" in each place such term appears.

(2) Section 704(c)(4) of such Act is amended by striking out "nine".

(b) Section 705(a) of such Act is amended by striking out "nine".

(c) Section 706(b) of such Act is amended by striking out "nine" and by striking out "ten-year" and substituting "five-year".

(d) Section 704(e) of such Act is amended by adding the following at the end thereof: "Not later than five years after the date of the enactment of the Energy Security Act, the Task Force shall submit a final report setting forth in detail the recommendations of the Task Force under subsection (b)(14).".

(e) Section 704 of such Act is amended by adding the following at the end thereof:

"(g) In carrying out the program objective set forth in subsection (b)(9)(B), the Task Force shall examine the usefulness of precombustion treatment of fuels in reducing sulfur dioxide and nitrogen oxide emissions and shall also investigate the potential for long-term reduction in such emissions which may be achieved through the implementation of inherently low-polluting combustion processes, such as atmospheric fluidized bed combustion and pressurized fluidized bed combustion.

"(h) In carrying out the program objective set forth in subsection (b)(11), the Task Force shall actively solicit data, views, and comments from State agencies which are carrying out studies and research relating to acid deposition.".

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Mr. SCHEUER. It is my great pleasure to yield to our very distinguished and contributing ranking minority member, Mr. Carney of New York.

Mr. CARNEY. Thank you very much, Mr. Chairman.

Mr. Chairman, this subcommittee has met on previous accounts to discuss the perplexing topic of acid rain. Certainly it is evident to all of us here that the problem does indeed exist and that solutions must be found.

As I have stated before, I view acid rain as a timebomb that we are faced with, and action must be taken to prevent further degradation of our environment.

We are here today to discuss acid rain legislation, specifically H.R. 5055, the Acid Precipitation Accelerated Review and Reporting Act, introduced by Representative Nick Joe Rahall, and H.R. 4830, the Acid Rain Research and Implementation Act of 1981, introduced by Representative Judd Gregg, who is a member of the overall Committee on Science and Technology.

I would like to commend my good colleague, Congressman Judd Gregg, for the initiative and leadership he has exhibited in the House on the subject of acid rain. As a cosponsor of H.R. 4830, I share with Mr. Gregg the urgency for implementing means to eliminate acid precipitation, for enhancing the exchange and access to scientific data, for improving control strategies, for recommending alternatives to these strategies, and for methods of raising the necessary capital for such implementation.

I look forward to hearing the testimonies of both Congressmen Gregg and Rahall, commending Mr. Rahall, too, for his attention on this problem. I thank all of our other witnesses being present here today. We can only benefit from your contributions.

Mr. Chairman, I wish to take no further time away from today's testimonies. I thank you for having selected this subject as one for our subcommittee to address. Acid rain is one pressing issue and you, Mr. Chairman, have certainly shown us the high importance that you attach to this matter.

Thank you, Mr. Chairman.

Mr. SCHEUER. I thank my distinguished colleague.

Now I would like to call on Mrs. Schneider of Rhode Island, also a very active, contributing member of this committee, for her remarks.

Mrs. SCHNEIDER. Thank you, Mr. Chairman.

I will be very brief because I know that Judd Gregg is in a big hurry to provide us with all of the basic information necessary on his bill.

I will say that I also commend my colleague, and I am most enthusiastic about us not only hearing the testimony on this bill, but I am most anxious to have us report this bill to the full committee and take it to the floor of the House.

There is no question in my mind that not only the people of the New England region, which Mr. Gregg and I happen to represent, but people beyond that region are currently being severely impacted by the detrimental effects of acid rain.

There is no question in my mind that this is an issue that requires great urgency on the part of the U.S. Congress.

We have the determination to focus on research. However, we must move beyond the research element and move into the deterring element of deterring future degradation by acid rain. Any efforts toward monitoring I feel would be to the best interest of all peoples.

In addition to that, the whole issue of acid rain not only has national implications, but our neighbors to the north in Canada are also most enthusiastic about seeing some initiative being taken by our country.

So, I welcome Mr. Gregg, and thank you, Mr. Chairman, for the opportunity to comment on this very important bill.

Mr. SCHEUER. Thank you very much, Congresswoman Schneider.

The committee is in recess for 12 minutes.

[Recess.]

Mr. SCHEUER. We will proceed with Congressman Gregg, who will describe his bill to us. In the meantime, let me announce the arrival of our distinguished colleague, Mr. Sensenbrenner, from Wisconsin.

Our distinguished colleague from New England. Mr. Gregg, the floor is yours for however much time you may need.

STATEMENT OF HON. JUDD GREGG, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW HAMPSHIRE

Mr. GREGG. Thank you, Mr. Chairman.

I certainly appreciate this opportunity to speak before your committee, and I want to congratulate the chairman and the ranking members of the committee for being the point committee in the Congress for the willingness to take up acid rain and the willingness to address it.

I had the opportunity to participate with you up at Lake Placid, where you developed an excellent panel which presented well the issue of acid rain.

I have had the opportunity to sit in also on some of your hearings where you had a delegation of scientists—I think there were approximately eight or nine—leaders in their field, addressing the issue of acid rain. You are really to be congratulated for taking this leadership role. It is the type of leadership this Congress needs on this very vital issue.

Because I know this committee is extremely familiar with the issue of acid rain, I won't go into any depth on the background. We were all up there in Lake Placid when Congressman Martin came in through the rainstorm, which we all drove through, and told us that the acidity of it was 4.15, which worked out to the same acidity as orange juice.

It is a very serious situation for us in the Northeast. It is a serious situation for Canada. It is a situation which I described this way.

If the utilities in the Midwest or the producers of the sulfates were putting the byproduct of their energy production in tank trucks and driving it to the Northeast or to Canada and opening up the back of the tank truck and pouring it into our lakes and thus killing our fish life and having a significant impact on our forest industry, obviously immediate steps would be taken to bring that under control.

But because it comes through the air, it becomes a little more difficult to handle. It is having the exact same effect as if it were being tanked to us by truck. It is just that it is a little more difficult to get a grasp on with people's perceptions.

Mr. **Scheuer**. Would not you also add as part of the inherent inequity of the situation their cost savings from not having to invest in any significant pollution controls.

In other words, our electricity consumers are paying an exaggerated bill for environmental controls due to the fact that the energy consumers in the Midwest may have to pay little or nothing for environmental controls?

Mr. **Gregg**. That is absolutely correct. What we are doing, the Northeast and Canada, is basically subsidizing the energy costs of the Midwest through allowing our environment to be reduced in its pristine nature in order to dispose of their hazardous waste.

In addressing this issue, which is obviously an essential issue to New Hampshire, to New York, to many other parts of the country also which may arise from different source areas, we developed a bill which is before this committee, 4830.

The purpose of this bill is to get into the whole issue of research and expediting research activity.

I want to thank Dr. Moss of this committee for his invaluable help in evolving the bill itself.

In developing the bill, we came to the conclusion that we should get some comment on the bill. So, we sent it out to 400 different organizations before it was ever introduced.

These organizations were across the whole spectrum, the absolute whole spectrum, from those people who might be considered as the extreme environmentalists to those people who might be considered as taking a very different viewpoint.

We received back a tremendous response. We received back over 100 responses, in-depth, substantive discussions of the bill. From those responses, we synthesized this bill. There were two basic points which came out of these responses, however, that became clear to us and which required us to take another look at the whole situation.

First, yes, sir, there is a definite need for more research in order to obtain some very long-term solutions to the problem and in order to address some of the issues which have not necessarily been definitively answered yet.

At the same time, there is enough knowledge in the area, enough knowledge in the scientific community to identify very clearly, according to the National Academy of Science, that the emissions from the coal burning plants in the Midwest are a significant contributor to the sulfate problems which we have in the Northeast, and to the acid precipitation problems, and that there are regulatory activities which can occur today and which can respond to this.

For this reason, we developed a two-prong approach to the whole issue. The first prong of that new approach is our bill, 4829, known as the Moffett-Gregg bill, which was introduced in the Senate as the Mitchell bill.

This bill talks about short-term strategies and attempting to reduce sulfate emissions by 10 million tons over a 10-year period. It requires certain action within a 31-State region east of the Mississippi. It does require immediate regulatory relief, and that relief is appropriate.

In fact, when the panel—which this committee had before it I guess it was about 2 weeks ago now—spoke, although there was some disagreement as to the scientific facts, there was general agreement that this sort of two-pronged approach should be taken. There are short-term measures that can be effective; but there is also a need for long-range research in the areas where there are still scientific questions.

So, along with the Moffett-Gregg bill, the 4829 bill, the second prong of our approach—and they are collateral in nature—is the 4830 approach. This bill, which this committee has before it, essentially accelerates the present activities of the acid precipitation task force, which now has a 10-year life but in our opinion has sort of an amorphic charge when it reaches the end of that life as to what it should do in taking action with its findings and further has no specific charges to take action in the intermediate steps of its lifetime.

So, this bill requires that after 12 months, there be a report delivered to the Administrator, who is the Administrator of the EPA, assessing the findings and the scientific evidence of the period.

At that point, if there are definitive scientific positions and findings of cause for acid precipitation problems, then it also directs that the Administrator take regulatory action and consult with the National Academy of Sciences in doing this.

I believe this bill is an essential step forward in addressing the whole issue of acid rain. To the extent that people argue—and there are some legitimate arguments on the issue of how what goes up affects what comes down—to the extent that argument is made, there is a tremendous amount of scientific investigation going on to try to answer it.

The answers, in my opinion, are in the pipeline. I think the testimony we have heard from scientists clearly reflects that within the next 2 to 3 years they are going to be able to definitively identify the relationships between what goes up and what comes down.

At that point, we must have in place, in my opinion, the long-term regulatory strategy or procedures for establishing long-term regulatory relief so that there is no longer any delay in this area.

This bill grants that sort of authority to the Administrator and looks to the National Academy of Sciences as an arbiter of the issue.

It also, I believe, accelerates and points a much more precise finger for the scientific community to follow by directing that a response be made within 12 months, and then after that, every 24 months, and thus focusing with much more intensity the activities of the acid precipitation task force.

So, these are the basic structures of the two-prong attack which we have suggested. Clearly the importance of movement in this area in the near term is essential to those of us who are suffering from the costs of acid precipitation. I certainly appreciate the fact that this committee has been willing to take a look at this bill at this early date.

I also, of course, appreciate the fact that the chairman, the ranking Republican, and other members of the committee have already cosponsored the bill, which I believe improves its chances for consideration. I look forward to participating with the committees as the bill is evolved and discussions on the bill occur.

Thank you very much, Mr. Chairman. I would be happy to answer any questions you may have.

[The prepared statement of Mr. Gregg follows:]

Statement Of
Representative Judd Gregg
New Hampshire
On
Acid Rain Mitigation Strategies
Before
Subcommittee On Natural Resources, Agriculture Research And Environment
Of The
Committee On Science And Technology

December 8, 1981

As a Congressman from New Hampshire, a state which relies heavily on its natural resources as a source of commerce and recreation, I am extremely concerned about the adverse effects of acid rain. It is the most critical environmental problem facing New Hampshire, the Northeast and Canada and must be addressed immediately in order to mitigate the problem before the damage becomes irreversible.

Acid rain is primarily an environmental problem. Its effects are pervasive - destruction of aquatic ecosystems in high altitude lakes and further downstream pollution caused by the acidification of those lakes; degradation of soil resources; reduction of farmland and forest growth; and damage to existing crops. Research and development on the causal effects of acid precipitation on aquatic and terrestrial ecosystems indicates that it is the chief contributor to the extinction of fish life in over 180 lakes in the Adirondacks, alone, and approximately 140 lakes in Ontario. Further studies conducted in Vermont suggest that increased acid levels in soils have contributed significantly to a 45 percent reduction in density of Red Spruce growth in the state.

Increased research and development on acid rain has further revealed the far-reaching economic consequences of this problem. States such as New Hampshire which largely depend on its timber industry, tourism and farming as a primary source of income have already been substanatively affected by acid rain. A Northeast Damage Report, prepared by the Northeast States for Coordinated Air Use Management conservatively estimates annual economic losses in 1980, for the northeast, between $400 and $500 million as a result of acid rain.

Further, the acid rain problem has adverse international ramifications. Our neighbor to the north, Canada, is extremely distressed about the large quantities of sulphur dioxide generated in the United States, transported north and deposited as sulphates in Canada. Prime Minister Trudeau has made Canada's concerns evident to the United States on numerous occasions, but until mitigating efforts are employed, this issue will serve to strain U.S. - Canadian relations.

Based on these adverse effects of acid rain, and on my conviction that the problem is critical enough to act now, I have sponsored legislation calling for immediate regulatory control of sulfur dioxide emissions coupled with increased research and development on the problem.

I must emphasize that I believe enough empirical data exists, attributing the cause of acid rain to SO_2, emitted from coal burning power facilities, to employ immediate interim control strategies. However, acid rain has been an unusually difficult problem to resolve because the precise source - receptor, and cause and effect relationships, have been difficult to conclusively determine.

For this reason, I have proposed a collateral, two-pronged approach to this problem which first acts upon existing data and analysis to control SO_2 emissions, and second, recognizes the unknowns of the acid rain phenomena and moves to arrive at the most cost-effective, long-term solution available, based on sound research and development.

As a part of this approach, H.R. 4830, the Acid Rain Research Implementation Act of 1981, plays a key role.

While in total support of the immediate regulatory control of SO_2 emitters, I, as well, acknowledge that many questions regarding acid rain have yet to be answered. For instance, we know that SO_2 and NO_x can be transported over long distances in the upper atmosphere and by a complex series of photochemical reactions transformed into sulfuric/nitric acids and be deposited back on earth. However, at this time, exactly how this process takes place is an issue.

Further, there is certainly evidence to establish a cause and effect relationship between SO_2 emissions in the midwest and acid precipitation in the northeast and Canada. At present, however, we have not resolved the exact numerical relation between a decrease in emissions and the corresponding reduction in deposits.

By addressing questions like these through careful data analysis of the effects of SO_2/NO reduction through various control techniques, accompanied by significantly increased generic research on acid rain, we will be able to develop and employ the best available environmentally protective, long-term control strategies.

Consequently, this two pronged approach should also expedite development of the most cost-effective long-term controls possible and incite the private sector to participate in this development. For, with increased research and development on the cause and effect relationship of acid rain, and on the effectiveness of previously applied control techniques, industry will be provided with the information needed to force developing technologies. However, as outlined here, neither an interim control program or a research implementation plan, on its own, will be enough to expedite the most environmentally secure, and cost-effective, long-term solution possible.

Regarding H.R. 4830, the Acid Rain Research and Implementation Act of 1981, its primary purpose is to establish a better technical base upon which to build an effective and efficient control program through significantly increased research and development. This legislation converts the existing ten year research program of the Interagency Task Force on Acid Precipitation into a directly targeted effort to better understand the causes and effects of acid rain, the source-receptor relationship and how best to mitigate these problems. Under this plan, the Environmental Protection Agency Director would be required within 12 months after the enactment of this law, and at least every 30 months following, to determine the need for new or supplementary regulatory control based on the research and development of the Interagency Task Force and recommendations from the National Academy of Science. Presently, the Task Force, which is the only federal organization seriously investigating acid rain, will report after a ten year study period. This ten year research program is too long and leaves no room for regulatory action to be implemented on an orderly basis when it is necessary. As a part of this bill, Congress would have the task of oversight to ensure the timely completion of reports and recommendations the and responsible action on the part of the EPA Administrator.

As a final point, this bill mandates an open communication process as acid rain data results are integrated. This will serve to inform industries, state and local governments and our international friends of our data analysis and control strategies to be used.

The manner in which I developed the Acid Rain Implementation Act of 1981, and this two pronged approach for addressing the problem, in both the short and long term, is of importance to this testimony and development of this program.

After deciding in March 1981, that specific acid rain language should be incorporated in the Clean Air Act during the reauthorization process, I drafted a proposal similar to H.R. 4830. This draft copy was sent to over 400 state, regional, and national environmental groups, manufacturing associations, industries and concerned citizens for comment Over one third of those mailed to responded to our inquiry. The high majority of those responding, both representing environmental and industry concerns, recognized that there is a problem and that action is necessary.

Upon further analysis, two consensus opinions became evident calling for immediate control strategy on the one hand, and increased research and development on the other. In devising a strategy, I resolved to address both concerns by coupling the research approach with a control program. Concerning H.R. 4830 specifically, language was tightened to ensure that increased research and development was not merely for the accumulation of data. The bill now is designed to better determine the cause and effect relationship of acid rain so that the best available control strategies can be applied.

During the reauthorization of the Clean Air Act, the acid rain problem must be addressed and the Act strengthened.

A recent Harris Survey poll demonstrated overwhelming public support in America for making current environmental laws even tougher. Of those polled, 38% want to make the Act stricter, 48% favor keeping the Act as it is, and only 12% want to make it less strict. Lou Harris concluded: "Clearly there is no mandate at all for repeal of or serious cutback in the Clean Air Act; instead, the trend is toward even stricter enforcement of the present regulations.

The pattern of support, as indicated in the Harris Poll, for at least maintaining present environmental laws, and in many cases making them stricter, should offer guidance to Congress when addressing acid rain and reevaluating the Clean Air Act.

New Hampshire residents have demonstrated to me that acid rain is of primary importance to them. In redrafting the Clean Air Act, I will take an active role in developing solutions to this problem and maintaining the utility of the Act.

Mr. **Scheuer**. Thank you very much.

I am happy to yield to my distinguished ranking minority member.

Mr. **Carney**. Thank you very much, Mr. Chairman.

Again, I would like to thank Mr. Gregg for his legislation. I suspect we will be going into a markup phase on legislation pertaining to acid rain in the near future. I was wondering if you believe that H.R. 4830 can stand on its own as a solution to the acid rain problem?

Mr. **Gregg**. No; I think that we must move forward also with some immediate regulatory activity. That is why I introduced the Moffett-Gregg bill.

Mr. **Carney**. What are the costs to implement the bill? Have you given it any consideration?

Mr. **Gregg**. I would have to get those costs for you, but since the acid precipitation task force is already in place, I do not believe they would be significant.

Mr. **Carney**. It is the intent of the bill to use the task force and just accelerate the reporting requirements?

Mr. **Gregg**. Yes, sir, under the task force obligations, and then should the task force reach a conclusion that is supported by scientific evidence, move into regulatory action. At that time there would be additional costs, obviously.

Mr. **Carney**. Your State has been a leader in this issue, and I was wondering—and I am sure you have, having dealt with the State legislature and members of your environmental agencies there—are they supportive of this two-prong approach to find a solution to acid rain that is both a regulatory and research strategy?

Mr. **Gregg**. Yes, sir, they are. Not only are the people in the United States supportive of it, but I have found that other people who are extremely concerned with the issue of acid precipitation also are supportive of this approach.

Mr. **Carney**. This is the proverbial "here is a hand grenade" question. What criticisms have you received regarding this legislation, if any?

Mr. **Gregg**. Well, that is a bit of a hand grenade question.

Mr. **Carney**. Think of it this way. I am on your side of the aisle. Wait until the chairman starts.

Mr. **Scheuer**. Why don't you divide up that question into two sections—the totally irresponsible and demagogic criticisms and the reasonable and compassionate criticisms.

Mr. **Gregg**. What we did by sending out the bill to 400 individuals and institutions which have credibly diverse views on the question was to raise innumerable criticisms. That was the purpose of it, to get commentary before we put it into legislative form.

In getting back the letters, we divided them up into categories of criticism and tried to work through those criticisms which we felt were valid. Quite honestly, we have tried to amalgamate into this bill from the original draft most of those criticisms which we felt were effective criticisms.

There is, obviously, a fundamental disagreement within the national community, and specifically the Midwest versus the Northeast. We all know from some of the testimony at some of the other committees that there are members in the Midwest who, first, do not acknowledge that acid rain exists, and second, if it does exist, that it is not being caused by the Midwest, and if it is caused by the Midwest, they have no responsibility to correct it.

Any bill which tries to move that issue along receives significant criticism from that segment of the community. But I believe that there is a sense within the responsible communities of the energy producing segment, and they are mostly responsible, quite honestly.

We had very responsible commentary, that more research is essential in some areas and that expediting of that research schedule is appropriate. I guess if there is disagreement, it is probably going to come with the fact that this bill not only expedites the research activity, but also requires that once the research activity has identified a cause, that regulation shall occur.

That is the second step which possibly—in fact, probably—many people would object to. I happen to feel that that is the teeth of this bill and is a very essential part of it. So that is basically the criticism which we confront.

Mr. CARNEY. Have you had any input from our neighbors to the north in Canada?

Mr. GREGG. Yes, sir. We dealt closely with Canada on this action, and we received a lot of positive response from Canada. I am not sure that they are in the policy of getting involved in legislative matters on this level because they probably deem it to be inappropriate.

We have worked closely with them because I think the Canadians have as much invested in this problem and as much of a concern in this problem as we do.

Mr. SCHEUER. They have certainly been hurt far worse than we have. The impact has been devastating on them.

Mr. GREGG. It appears that the land area which is impacted falls as much in Canada as it does in the United States, if not more.

Mr. SCHEUER. For example, their forest products industry is a very substantial percentage of their economic activity.

Mr. GREGG. Well, they have three major economic sources. They have tourism, they have forest products and they have the whole issue of water. Their needs for water in all of those are being seriously impacted by this.

Mr. CARNEY. The Council on Environmental Quality has been doing an enormous amount of study on this issue. They are, I believe, about to report on acid rain sometime in the early part of 1982.

Have you been in contact with the Council? Have you had any opportunity to get a preview of their study or their report to this point?

Mr. GREGG. No, I have not.

Mr. CARNEY. Has there been any mention of conflict?

Mr. GREGG. Not that I am aware of. I have not been in contact with them.

Mr. CARNEY. The Council has not contacted you?

Mr. GREGG. Not that I am aware of. They may have talked to staff, but I have not talked to them.

Mr. CARNEY. Mr. Chairman, those are the only questions I have of the witness. I would just like to thank him.

Mr. **Scheuer**. Thank you very much.

Our distinguished colleague from Rhode Island.

Mrs. **Schneider**. Thank you, Mr. Chairman.

I wonder, Mr. Gregg, if you could please elaborate on the extent of regulatory control that is implied by the bill?

Mr. **Gregg**. Well, I think that depends on the problems identified, because of the precipitation. The bill attempts, basically, to get input, in fact requires that input be made by the private sector in the regulatory decisions and also in the decisions on the scientific issues. We would hope that the regulatory response would be limited to that necessary to be effective.

It does not anticipate what that is because it does not anticipate what the scientific evaluation will be. It just requires, first, that if a scientific evaluation is reached that the problem can be solved through regulatory action that regulatory action must take place, but it does not anticipate what that is.

Mrs. **Schneider**. What do you foresee the implications of the monitoring provisions of this bill being? To what degree will it improve over the status quo?

Mr. **Gregg**. Well, I think it will improve it significantly because, as I mentioned earlier, it targets and makes a much more precise timetable for the acid precipitation task force to follow and makes it much clearer that the decisions of that task force are going to have significant weight and be translated into action.

Mrs. **Schneider**. That is the extent of my questions. Thank you very much.

Mr. **Scheuer**. Thank you.

Congressman, we very much appreciate your testimony. We appreciate even more the great diligence and clear insights that you brought to this whole problem. We look forward to working with you in the months ahead.

Thank you very much.

Mr. **Gregg**. Thank you, Mr. Chairman.

Mr. **Scheuer**. We will now hear from the Honorable Nick Joe Rahall, Democrat, of West Virginia.

We have already moved that your bill be printed in its entirety when we started this hearing, Congressman, so we would be happy to yield to you such time as you may need to tell us all about your bill.

We are very grateful to you for involving yourself in this subject in a very supportive way, and we look forward to working with you and look forward to hearing about your bill.

STATEMENT OF HON. NICK JOE RAHALL, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF WEST VIRGINIA

Mr. **Rahall**. Thank you, Mr. Chairman, and members of the committee.

I do appreciate the opportunity to testify this afternoon on the bill that I along with eleven original cosponsors have introduced, H.R. 5055, the Acid Precipitation Accelerated Review and Reporting Act.

I also appreciate the opportunity to listen to the testimony of Congressman Gregg in regard to a bill he has introduced on the very same issue, and I hope to address during my presentation this afternoon the question that Congressman Carney put to Congressman Gregg, and perhaps that being in regard to criticism of his bill.

I do have a couple of minor disagreements with him.

As chairman of the congressional coal group in the House of Representatives, I can share his concern—as I am sure other members from coal-producing or coal-consuming districts of this Nation share the same concern as our counterparts from New England—over the potential harm that is caused by acid deposition.

We share not only our counterpart's concern, but the concern of our Canadian friends from across the border. We are dedicated toward obtaining answers to questions that are raised during consideration of the causes and effects of acid precipitation

I have long held the notion that when considering an issue as complex as acid deposition, we in Congress must don the analytical and impartial guise of the scientist. There are innumerable fallacies associated with the causes and effects of acid precipitation which only sound scientific research can resolve.

There is also a great deal of emotionalism when headlines are interpreted in the wrong manner. It is not a new phenomenon, as some would suggest. Indeed, the French chemist J. A. Barral in 1852 estimated that rain falling on Paris had a pH value of 4, which is on the acidic side of "natural" rainfall with a pH of 5.6.

So, acid precipitation is not solely caused by emissions of sulfur dioxide, which is another commonly held belief not founded in science. But as I will show, there are other causes, also.

In addition, and perhaps most importantly, it must be recognized that the scientific community has yet to reach consensus on the atmospheric conversion of acid precipitation precursors and on the long-range transport of sulfates and nitrates.

Perhaps the most controversial aspect of the acid rain issue is its cause. Acidity in precipitation occurs through both anthropogenic and manmade sources. While there is still uncertainty over the contribution of each, when considering the former it is known that sulfur dioxide and nitrogen oxides—and I stress nitrogen oxides—can undergo oxidation in the atmosphere to sulfates and nitrates, falling to the Earth in solutions of sulfuric and nitric acid.

On the average, the ratio of sulfates to nitrates associated with hydrogen ions in acid precipitation is 2 to 1. However, nitrate levels are on the rise, especially in the West.

While the atmospheric conversion of the major precursors to acid rain appears ostensibly simple, it is in fact enormously complicated. There are numerous factors associated with this transformation, including sunlight, temperature, humidity, catalytic particles and oxidants, such as ozone and hydrogen peroxide. Hydrochloric acid has been identified as contributing between 5 and 10 percent of the acidity in rainfall.

Mr. Chairman, there presently exists no credible body of evidence to support immediate and costly new controls on sulfur dioxide emissions—and emissions of sulfur dioxide only—in an effort to reduce occurrences of acid deposition.

All of the available information we have instead argues for a more vigorous program of research into atmospheric chemistry before any control measures are selected.

In Congressman Gregg's testimony he did point to some facts that are currently known, facts which I do not argue. However, he referred to the fish kills that are occurring in the Northeast part of the United States. I would point out that according to Dr. William Wilson of EPA's Environmental Science Research Laboratory, and I quote, "If the goal is to reduce spring fish kills in the Northeast United States and Canada, control of nitrogen oxides from utility and industrial boilers or from automobiles may be more effective than installation of wet scrubbers on coal-fired powerplants."

Proposals to control sulfur dioxide emissions only, I believe, presents a haphazard approach to this issue. They do not take into account the contribution made by nitrogen oxides, nor the role of catalytic particles and oxidants in the atmosphere.

It is an extremely costly approach if proven incorrect, to both industry and consumer. One estimate states that a reduction of sulfur dioxide emissions by 10 million tons over a 10-year period could have a consumer impact of $3.2 billion per year for increased fuel costs alone. Furthermore, thousands of mine workers could lose their jobs, which in Appalachia means an overall depressed economy.

Mr. Chairman, I would like unanimous consent at this point to insert in the record a study that was done by the United Mine Workers of America in regard to S. 1706, as introduced by Senator Mitchell.

In this study, which is not lengthy, it does state the number of coal mining jobs that could be lost if these controls were instituted immediately, the loss to the economy in dollars, and the ripple effects throughout the economy in our coal-producing regions, and indeed in our Nation.

I would like to insert that with my testimony at this point.

Mr. SCHEUER. Without objection, so ordered.

[The information follows:]

REVISED

NOVEMBER 1981

EMPLOYMENT IMPACTS IN PRODUCING STATES

	TOTAL TONS OF COAL DISPLACED (X000)	WEIGHTED AVERAGE ANNUAL PRODUCTION PER WORKER	DIRECT MINING JOBS LOST 1/	TOTAL JOBS LOST 2/
Alabama	12,289.4	3,038	4,046	16,184
Illinois	45,260.9	3,737	12,112	48,448
Indiana	24,677.8	6,123	4,043	16,172
Iowa	317.0	2,735	79	316
Western Kentucky	34,632.8	3,858	8,976	35,904
Maryland	1,067.2	2,676	396	1,584
Missouri	3,024.3	4,620	655	2,620
Ohio	31,382.0	4,010	7,826	31,304
Pennsylvania	46,289.4	3,094	14,961	59,844
Tennessee	6,492.6	2,621	2,477	9,908
Virginia	6,768.6	2,308	2,933	11,732
West Virginia	31,259.8	1,878	16,645	66,580
TOTALS	243,461.8 3/		75,149	300,596

1/ Does not include management and support staff.

2/ Computed by multiplying direct mining jobs lost by 3.0 and combining direct jobs and indirect jobs. The multiplier is based on Department of Commerce estimates.

3/ Remaining production losses of 63,604,700 tons occur in states outside the 31-state region and in Eastern Kentucky where no net loss in employment is expected.

Mr. RAHALL. We in Congress, as you know, realized that not enough information on the causes and effects of acid precipitation is available when we passed the Energy Security Act last year.

As you know, title VII created an acid precipitation task force with a mandate to formulate a comprehensive research plan under a 10-year program. The task force is to identify the causes and effects of acid precipitation and actions to limit the potential harmful impact of this phenomenon.

The legislation which I have introduced recognizes that this program provides the Congress with an established framework for synthesizing existing scientific data and developing additional information relating to acid rainfall.

While H.R. 5055 does not preclude the task force from submitting an annual report to the President and Congress on its progress, as currently called for under title VII, it does request quicker action and a final report not later than 5, rather than 10, years after the date of enactment of the Energy Security Act.

Included in this final report would be the recommendations of the task force pertaining to actions needed to alleviate acid precipitation and its effects.

Mr. Chairman, I would ask why should we negate the past affirmative actions of Congress by rushing headlong into new controls before the results of what we asked for in the past year are actually known to us?

Let me note at this point that I do not believe scientific research can be legislated. However, in light of the 75-percent increase in funding for the task force in fiscal year 1982, which was requested by our President, similar research being done by non-Government entities, such as the Electric Power Research Institute, which has already spent $14.5 million in this area, and the scientific uncertainty posed by proposals seeking to implement new and costly controls on sulfur dioxide emissions only, I feel we will be in a better position to pass judgment under an accelerated 5-year program than to impose controls at this time.

Aside from this aspect of my bill, other provisions give direction to the task force by suggesting it investigate the feasibility of inherently low-polluting combustion technologies, such as atmospheric and pressurized fluidized bed combustion and precombustion fuel treatment, such as coal washing, in reducing sulfur dioxide emissions.

These techniques offer a much more cost-efficient approach to emission control than currently used once fully developed for commercial application. The advantages generally associated with fluidized bed combustion, for example, include reduced emissions of sulfur and nitrogen oxides, increased energy conversion efficiency, and a solid waste easier to dispose than that from a wet scrubber applied to conventional boilers.

Mr. Chairman, let me conclude by saying that we should not be frightened into action by unscientific charges on the environmental harm that may be caused by acid precipitation. More and better information is needed before any massive regulatory campaign is launched.

It is my hope that H.R. 5055 will provide us with the means for obtaining this information in an expedited fashion so that we can continue to achieve energy security through the use of domestic coal in an economical and environmentally sound manner.

That concludes my prepared testimony. I will be glad to respond to questions, Mr. Chairman.

Mr. **Scheuer**. Thank you very much for your very thoughtful testimony.

You mentioned that a high level of acid rain regulatory controls could cause grave unemployment in West Virginia. Could you tell us what the unemployment is and what you think the impact would be?

Then there is a second collateral matter, whether there are any sources of low-sulfur coal in West Virginia and elsewhere, where in Appalachia that could perhaps be substituted for your high-sulfur coal.

Mr. **Rahall**. Yes, sir, Mr. Chairman. To respond to the first part of your question, unemployment among our Nation's coal miners at this point, as estimated by the United Mine Workers of America, is around the 22,000 figure. In West Virginia alone, 7,000 to 8,000 coal miners are estimated to be unemployed.

I might add that this does not take into account the side effects of unemployment, the hardship on the community, the related loss of jobs in equipment manufacturing, ripple effects in the business community, all of which are related very closely to the ups and downs and the employment in the coal-mining industry.

In regard to the second part of your question, as to whether low-sulfur coal in West Virginia could be used to meet stricter environmental standards, the answer would be yes, sir, and especially in my congressional district, which produces the low-sulfur, high-grade metallurgical coal used in the coking furnaces of our Nation's steel industry.

However, I might qualify that by saying that is a very parochial way to look at it. My district is not typical of the entire State of West Virginia, nor other parts of Appalachia, Pennsylvania, Ohio, Kentucky, and Virginia, where the coal is not of such a high-grade quality.

If we are to pursue a national policy in this country of reducing our reliance upon foreign imports through use of domestic sources, then I believe it is necessary that we look at the longer range, overall implications for the entire coal-producing regions of our Nation.

Mr. **Scheuer**. You could, because you have the availability of low-sulfur coal, commence a gradual shift to low-sulfur coal on an economic basis?

Mr. **Rahall**. Yes, sir, we could. We could supply it and would be more than happy to supply it.

Mr. **Scheuer**. Well, you are very fortunately situated there.

Your bill mandates that the acid rain task force take a more active role in promoting research into coal washing and to low catalytic combustion technologies.

Have either companies in your State or has your State itself received help from either the EPA or the Department of Energy in developing these technologies?

Mr. **Rahall**. We have, in the past, received such help. The Department of Energy fossil fuel research and development budget, however, as submitted this year, has been reduced. I guess slashed would be a better way of describing it.

The President, in submitting this budget, has stated his definition of Government's role in research should be long-term, high-risk technologies which, in practice, turned out to be nuclear fission and breeder reactors, which I regret to see, but that is the way the administration has presented its R. & D. program.

Fluidized bed combustion, into which my bill would seek to require further research, is a high-risk enterprise, in my opinion, and it is certainly a high-risk enterprise for the private sector. Commercial application to electric utility boilers is still some years in the future.

Some coal companies and other firms in the private sector have anted up moneys and are doing work in further research in this area, but nonetheless I don't think we are going to gain the benefits of fluidized bed combustion or coal washing or any of the other technologies that we need for some time to come, unless there is some role of Government in providing the necessary incentives for research or outreach moneys.

Mr. SCHEUER. Thank you very much.

My colleague from New York?

Mr. CARNEY. Thank you, Mr. Chairman.

Welcome, Nick. I enjoyed your testimony. I have a couple of questions.

Do you have any idea, have you done any study on the cost of the accelerated study from up to 5 years from what the costs were from title VII in their time frame?

Mr. RAHALL. No; I have not done any studies as to the costs, but I don't imagine there would be any additional costs over what the Congress has already made allowances for, the point here being not so much the costs of the study, but making the facts and the information known to us quicker so that we can proceed to whatever controls may be necessary after these facts are known, and in that manner prevent us from embarking at this point upon a very costly program that may prove costly in the future if our actions were shown not to be in the right direction.

Mr. CARNEY. I would like to talk for a minute about the unemployment situation as it relates to this bill, and with the indulgence of the Chair, I would like to talk to it as it relates to the problem that I have with coal in Long Island.

As it relates to this bill, as I see it, our Nation is committed to changing its primary fuel to coal. If we do that by putting safeguards at the point cf combustion or we do it without putting safeguards on, I would think that we are going to consume the same amount of coal to produce the same amount of energy.

If we were not to do that, we would probably have to consume more coal to get equal amounts of energy, given added energy drain-offs through environmental devices necessary. So why would there be a decrease in the amount of coal that would be mined? As I see it, what causes unemployment is when you stop mining.

Mr. RAHALL. That is true, but I am not sure that there would be a loss of coal needed should the scenario that you have described be developed. I think that because of these technologies that I have referred to in my testimony, and the research and the possible applications of it in the future, we are going to be burning coal cleaner using the same, if not more, amounts of coal under these new technologies.

I don't see that causing any loss of coal production in the years ahead. We have got the coal, certainly.

Mr. CARNEY. Where is the economic impact you speak of in your testimony? That is where I am lost. I would think under both scenarios we are going to increase the amount of coal production in the United States if we pass a bill or if we just continue to go along with the present title VII.

Mr. RAHALL. Well, the main loss would be if utilities are going to have to go with these environmental technologies that first are very expensive, and second, they are going to more than likely switch to low-sulfur coal or most unfortunate of all, continue using expensive, unreliable imported oil.

Now, as I stated, use of low-sulfur coal would benefit my district, yes, sir, but I think we have to look at it in the long-range in overall perspective of our country. That switch to low-sulfur coal would cause the loss of jobs in other coal-producing areas of Appalachia where there is not low-sulfur coal produced and high-sulfur coal may be used at present in utility boilers. That is where there would be a decline in production and a subsequent decline in jobs.

Mr. CARNEY. If we look at our natural resources, it is obvious that we don't have the high-grade, low-sulfur coal necessary to meet our needs for the next generation. We are going to have to burn high-sulfur coal whether we do it with very tight control or not.

If we are going to switch to coal, it is going to be a mix of both types, high- and low-sulfur. But we don't have a vast amount of low-sulfur coal available to us. So, as I see it, initially there might be a greater movement to burn the low-sulfur coal because technologies are not available to immediately apply to certain combustion techniques to enhance the quality of the air.

Mr. RAHALL. Not only that, but also because of current fuel adjustment passthrough clauses in many of the State public utility commissions and because of the current financial problems of the utility industry, they are going to find it in their best economic advantage to switch rather than install the technology.

Mr. CARNEY. To switch to what?

Mr. RAHALL. To switch to low-sulfur coal.

Mr. CARNEY. But again, we are talking about a very limited resource in low-sulfur coal. If our utilities went to low-sulfur coal, how long could we burn low-sulfur coal in the United States without having to rely on the higher sulfur coal, which is found in greater quantity?

Mr. RAHALL. Well, I don't know how long that reliance would last, but we cannot lose sight of the vast western supplies of such coal also.

Mr. CARNEY. Now, if the Chair would permit me to get off this bill for a minute, I don't have an opportunity to question my colleague on this issue frequently. I am confused about something.

Out on Long Island there has been a great emphasis in changing to coal. Many homes have gone through extensive renovations to put coal burners in, both because of economic incentives and because of the fear of not having the oil resource available in the future.

The problem that we run into is that we can't get the coal, that they have not mined enough. It is not available. I know there are transporation problems that are not associated with your region, but I was just curious to hear that there are 22,000 coal miners unemployed and yet last year, in fact, we took some emergency action to stop the shipment of American coal to Germany for the Army so we could bring it into the Northeast part of the United States because there was such a great shortage of it. We have not even started that conversion that we can anticipate in the future.

I was just curious. I know that has nothing to do with the bill, Nick, and I don't want to put you on the spot. I would love to sit down and talk to you. Maybe we can work something out.

Mr. **Rahall**. No, I appreciate your question, Bill. I would agree that when you look at the unemployment figures, it does not seem to make a great deal of sense today.

Conversion is the way to go. Many of the utilities in your part of the country have burned coal at one time in the past. They are coal capable. Legislation has been introduced for a number of years now, although modified recently, to provide the incentive to these utilities to provide the initial startup costs, tremendous costs that are involved in converting back to coal.

That has been one factor that has kept them from converting to coal, and continued reliance upon expensive foreign oil is the fact that it is expensive to initially convert to coal or reconvert.

Although they know in the long run that it is going to be to the consumer's best advantage and the utilities' best advantage financially, it is that initial startup cost that scares them.

That is why it is not being done. Although on a voluntary basis we are seeing in recent years a slight movement toward conversion. Hopefully by 1990 we will see more voluntary conversions, as utilities are more financially able to undergo those costs.

Mr. **Carney**. I have one last question. This is probably related to both the bill and the general industry itself; that is, How much coal now in Appalachia do you see being exported? How much of the low-sulfur coal that you mine is being exported?

Mr. **Rahall**. Well, I don't have the figures immediately available, but I could certainly provide those for the record.

[The information follows:]

In 1980, approximately 90 million tons of steam and metallurgical coal was exported by the U.S. In the first eight months of 1981, this figure was about 63 million tons of coal exported. Metallurgical coal accounts for about 60 percent of total coal exports. Coal from Appalachia—a region encompassing portions of 13 states and including 397 counties—accounted for over 90 percent of the coal exported by the U.S. West Virginia's contribution is about 40 percent. The dollar value of Appalchian coal for both domestic and foreign markets is estimated to be over $15 billion in 1981.

Nationwide, domestic coal production was 829.7 million tons in 1980 and for the first 10 months of 1981, 663.7 million tons. In 1980, West Virginia produced 121.6 million tons of coal making it the second largest coal producing state in the nation.

Mr. **Rahall**. Low-sulfur coal exports would be down at the current time, basically because of other problems in the steel industry. Also, Japan has not been importing as much of our low-sulfur coal as it did at one point. Steam coal is on the increase because of problems——

Mr. **SCHEUER**. Excuse me, Congressman. Do you know the reason why Japan is importing less of our low-sulfur coal?

Mr. **RAHALL**. I guess it would relate to the problems that their steel industry has been having also, Mr. Chairman, in addition to our own domestic steel industry.

Mr. **SCHEUER**. I understand that they have installed not only coal washers but scrubbers throughout their industrial plant, both manufacturing plants and utilities.

Would the fact that they have gone to scrubbers and, therefore, could use high-sulfur coal mean that they had less demand to pay for expensive low-sulfur coal?

Mr. **RAHALL**. Yes, it could.

Mr. **SCHEUER**. Thank you.

Mr. **CARNEY**. I think, Mr. Chairman, he did answer my question. I thank you very much for your most enlightening testimony. Hopefully we will be putting on the calendar your bill for markup in the future.

Mr. **RAHALL**. Thank you, Bill.

Mr. **SCHEUER**. Mrs. Schneider?

Mrs. **SCHNEIDER**. I would like to pick up on our discussion of technology and whether it is or is not in place.

I do have the good fortune to serve on the Energy Subcommittee on Research and Development, which my two colleagues here do not have that opportunity.

I will tell you that during this entire year we have listened to testimony and analyzing the various energy technologies that we do have at a demonstration and commercialized state. As a matter of fact, during the budgetary process our emphasis was to determine which type of technologies were available to be picked up by the private sector.

I will tell you that we had had numerous expert witnesses come before us talking about the various technologies, everything from the fluidized-bed-boiler reactor, which is currently being utilized in a variety of different spots throughout the United States.

We had great discussions on coal washing where one cleans the coal before it is burned. We talked about a variety of other types of pretreatment technological approaches toward dealing with coal.

I think there comes a time—as the chairman has pointed out about the Japanese also being in a technologically capable situation to burn coal in a clean fashion—that the utilities and the American public have to say, well, now is the time that we are going to set our priorities.

I also had the good fortune to take a trip to Japan most recently for purposes of dicussing energy. It came to my attention that the way the Japanese make decisions in their Government—and I think that this is useful for us as elected officials—is they determine what their priorities are.

If part of their priority is to protect the public good and to provide clean air, but also to burn coal as a resource, then they develop the technology that is suitable and that that is one of their priorities insofar as capital use is concerned.

You had made the point that the utilities find these technological fixes too expensive. Well, I think that if the utilities were to prioritize the types of technology that they want to invest their capital in, that they would perhaps find that coal would be much more cost efficient than many other technologies that they are currently involved in.

I think that when one focuses on the financial problems of utilities, perhaps it is comparable to some of the problems that the steel industry is having. If the steel industry were reinvesting in its own industry instead of buying condominiums in Florida, or Marathon Oil, or whatever, perhaps we would have a more solid steel industry.

So my point is that from the technological information that I have, the technology is in place for this type of energy use. I think that what we have to do as decisionmakers is to determine our cost-benefit analysis.

If we choose to take the route of preventive medicine where a penny saved today is a dollar earned tomorrow, I think that we would be much wiser to recognize the research that we have currently absorbed on acid rain and then set up a system whereby we can begin to diminish the impact of acid rain and generate the kind of support for this kind of legislation among the utilities as part of their corporate responsibility.

Mr. RAHALL. Well, I certainly do not mean to imply that these technologies are not existent today, and the reason for my bill is to make the first strides in those areas because, as you have pointed out, they are in use.

There is a fluidized-bed-combusion project here in Washington. They have a good track record thus far. That record needs to be extended and improved. The technology or the research into the technology is by no means at an end, and I think that we can expand and expound upon that technology to make it more widespread in its commercial applications in the future. That is certainly what I would like to see done.

The electric utility industries, as far as their corporate responsibilities to which you refer, I think have made remarkable strides in recent years for meeting that responsibility.

The economic climates of today, the high costs of capital, make it suicidal for them to make any type of commitment to install the technology or to install the conversion facilities that are necessary. Even under those trying circumstances where it is being done; for instance, at Braden Point in Massachusetts by New England Power.

I am sure as interest rates decline there will be more efforts made in this regard by the utilities with their own resources, and certainly there is some responsibility for State and public utility control commissions to examine their regulations within each State which allows a passthrough to the consumer.

But New England Power, at Braden Point, has demonstrated it is financially in their best interest in the long run, and their consumers, and I am hopeful we can see more of that in the future.

Mrs. SCHNEIDER. I am very hopeful that we can see more of that, too. I am just concerned that your particular piece of legislation might be detrimental to movement in that direction.

I would like to pick up on another point that you made in your statement, which said that you felt that there was unscientific evaluation of the impact of the burning of high-sulfur coal.

I think we, as members of this committee, should also point out that not too terribly long ago our Chairman Scheuer had pulled together about nine different scientists from around the country, a panel, and I believe this was the second hearing that we had already held on acid rain.

So, we have compiled an enormous amount of information, and it has been a very frustrating series of hearings because the solutions were difficult to specifically identify, but the causes were very clear.

Each of these scientists made the point that the causes of acid rain can be addressed by directing ourselves to fossil-fuel-burning plants and also to auto emissions.

Personally, I think from the testimony that we have accumulated the direction clearly points that the time for action is now. Otherwise, we do get into this situation where the Federal Government is paying for stopgap measures.

We are doing a cost-benefit analysis on human health versus investment by private industry. So, I think it was important to provide you with the information that we have also obtained.

Mr. **Rahall**. I am certainly aware of much of the information that has been gathered and, as I pointed out, I can agree with my predecessor's testimony in regard to the effect on fish kills.

I have said also that I don't think we can look only at sulfur oxides as a cost.

Mrs. **Schneider**. Yes, sir.

Mr. **Rahall**. That is what most of the available evidence that I have seen points toward. I don't think we can point the finger solely at that one cause.

Mrs. **Schneider**. I agree with you on that. I think we have to take a more comprehensive view of what some of the other causes might be.

Mr. **Carney**. Would the gentlelady yield on that point?

I was going to make that point, Mr. Rahall. This particular subcommittee is not looking at sulfur dioxide as the cause of acid rain. We pay equal attention to nitrous oxides and every other parameter or every other contributor to acid rain.

I know that you said that probably with good evidence. In other communities they might not take that viewpoint, but this subcommittee is looking at all the parameters involved in acid rain. I would just like that to be on the record at this time.

Thank you.

Mrs. **Schneider**. I think the only point that I would like to make in closing is that I am one of the strongest advocates of burning coal that you can find. I am not exactly what you would call a coal miner's daughter, but I was born and raised in Pittsburgh, Pa.

I do feel that we need legislation that will address the issue of maximizing the use of this natural resource that you do have in West Virginia, but doing it the right way. I think that in the long run it will have positive impact on not only human health, but also on the economy.

Thank you.

Mr. RAHALL. I can certainly agree with that.

Mr. SCHEUER. Nick, thank you very much for all the work that you put in and your deep concern with this issue. We look forward to working with you. We very much value your involvement and contribution. We are grateful for your appearance here today.

Mr. RAHALL. Thank you, Mr. Chairman. I commend you and members of the subcommittee and stand ready to assist you as you pursue your work on this issue.

Mr. SCHEUER. You have already been very helpful. We appreciate it very much.

Time is running on and we are running quite late. We have three panels and eight witnesses so from here on in I am afraid that we are going to have to ask the witnesses to stick to a 5-minute time limit. We have read all their testimony. All of the testimony of the witnesses will be printed in the record in its entirety and so we are going to ask all the witnesses to stick to 5 minutes.

The first panel will be composed of the Government witnesses: Mr. Alan Hill, Chairman of the Council for Environmental Quality; Ms. Kathleen Bennett, Assistant Administrator for Air, Noise, and Radiation of the Environmental Protection Agency; and Dr. John Byrne, Administrator of the National Oceanic and Atmospheric Administration.

We will start out with Mr. Alan Hill, then Ms. Bennett, and then Dr. Byrne, and I am sure we will have some questions for you after that. I apologize for the time constraints under which we are operating but since you are administration witnesses, you understand that this is the age of constraints: We have to learn to live with them, do we not? We will have to cope as best we can and I am sure you will all cope magnificently.

First, Chairman Hill.

STATEMENTS OF A. ALAN HILL, CHAIRMAN, COUNCIL ON ENVIRONMENTAL QUALITY; KATHLEEN BENNETT, ASSISTANT ADMINISTRATOR FOR AIR, NOISE, AND RADIATION, ENVIRONMENTAL PROTECTION AGENCY; AND JOHN BYRNE, ADMINISTRATOR, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Mr. HILL. Thank you, Mr. Chairman. For the record, I am A. Alan Hill, Chairman of the Council on Environmental Quality. We have indeed taken your advice and cut, squeezed, and trimmed the testimony to as brief a statement as possible.

Mr. SCHEUER. You have cut, squeezed, and trimmed everything else in sight, there is no reason why you should not trim your statement as well.

Mr. HILL. I am pleased to appear today to discuss the provisions of H.R. 4830 and H.R. 5055. Since the Council on Environmental Quality is an agency within the Executive Office of the President and because a number of Federal agencies are involved to varying degrees in the acid rain issue, the Council has been asked to coordinate the policy formulation process within the administration on this issue.

Before discussing the specific provisions of the bills, I would like to summarize the administration's views on the issue and the current activity which is now underway.

Federal activity on this issue is now proceeding on three different tracks. Administration policy on the acid rain issue is being formulated by a working group of the Cabinet Council on Natural Resources and Energy. This group is chaired by CEQ and is made up of policy-level representatives from a number of agencies.

This group should be distinguished from the bilateral working groups which were established under the memorandum of intent with Canada. These groups were set up to establish the scientific basis for negotiating a treaty with the Canadians covering transboundary air pollution.

Finally, an interagency task force on acid precipitation was established by the Congress in 1980. This task force is directed to coordinate the research efforts now underway both inside and outside the Federal Government.

My colleagues from EPA and NOAA will be discussing research efforts that are being undertaken which are of considerable concern. However, this research effort is just now getting underway and consequently it would be premature to embark upon a new control program now, especially given the substantial costs involved and the lack of assurance that such further control actions would produce the desired environmental results.

One of the main purposes of the bills being considered by the subcommittee is to promote an effective research program examining the acid deposition issue. H.R. 4830 attempts to do this by, among other things, creating a reporting system to the Administrator of EPA and the Congress by the acid precipitation task force. The reports required by the bill would be in addition to those now being undertaken by the task force.

The administration is committed to an aggressive acid rain research program. There is nothing in H.R. 4830 inconsistent with this goal. I do question whether imposing additional reporting requirements on top of those already existing is necessary.

H.R. 5055 would direct the task force to implement the comprehensive research plan which is to be developed under the 1980 act in 5 years rather than in 10 years as presently required. The legislation makes provision for a final report setting out its recommendations. This report is to be filed 5 years from the date of enactment of the Energy Security Act. Since the Energy Security Act was enacted in 1980, the report would be due in 1985. Finally, the legislation directs the task force to specifically examine innovative processes for reducing emissions, such as precombustion treatment of fuels and specified low-polluting combustion processes.

Although I would have to defer to my colleagues from NOAA and EPA as to whether we can realistically complete the necessary research in 5 years, the administration supports acceleration of the research effort to an effective conclusion in the shortest time practicable. Obviously, the sooner we gather the research data, the faster we can begin to solve the thorny problems the issue presents. I am not, however, prepared to tell you that we can complete the required research by 1985, as set out in H.R. 5055. The need for research will be a long-term one, considering the nature of the problem.

In closing, Mr. Chairman, I wish to close by emphasizing that the administration does recognize the serious implications of the acid deposition issue and is committed to developing a national program to address the issues identified by the research effort in an expeditious manner.

Thank you, Mr. Chairman.

Mr. SCHEUER. Thank you very much.

Ms. Bennett.

Ms. BENNETT. Yes, sir, Mr. Chairman, thank you.

I am Kathleen M. Bennett, Assistant Administrator for Air, Noise, and Radiation of the U.S. Environmental Protection Agency. In the interest of time, I will summarize my statement. I request that my complete statement be made a part of the record.

I am pleased to appear before you today to discuss the Agency's views on acid deposition, and in particular, H.R. 4830, the Acid Rain Research Implementation Act of 1981 and H.R. 5055, Acid Precipitation Accelerated Review and Reporting Act. Acid deposition has become an issue of increasing global interest in recent years, and a matter of concern to the administration and to Congress.

"Acid deposition" is a general term for the deposition of acidic materials, whether wet or dry, from the air onto the surface of the Earth or upon structures or objects.

Acid deposition occurs in varying degrees of severity in several parts of North America. However, the circumstances of its formation, the nature of its effects under various conditions, and the feasibility of potential controls are the subject of considerable debate. The question of appropriate remedial action therefore remains very uncertain.

Currently, we have considerable information on some aspects of the emissions of oxides of sulfur and nitrogen which can be the precursors of acid deposition. The majority of manmade emissions of sulfur oxides in the United States comes from utilities, while nitrogen-oxide emissions come mainly from transportation and from utilities and industrial boilers.

We know that emissions tend to be highly interactive, and that multiple emissions must be considered simultaneously.

Both sulfur and nitrogen oxides can be transformed before or after deposition into sulfuric and nitrogen acids by reacting with moisture as well as other substances in the atmosphere. Depending on a number of variables, emissions may be deposited relatively near their sources or transported over long distances.

Despite what is known about acid deposition, a number of major uncertainties in our current thinking remain to be resolved. These uncertainties include: The pH level at which precipitation should be considered acid, the process through which oxides of sulfur and nitrogen are transformed into acid deposition, the extent to which precursor emissions are transported and distributed, and the role played by local emission sources.

Additional uncertainties include the role of other photochemical pollutants and how they affect acidity levels and the relative importance of the potential effects from acid deposition on different receptors—that is, aquatics, forests, materials, et cetera.

Any remedial action must be based on reasonable certainty that it will, in fact, accomplish its intended purpose. The American people have the right to expect that their Government will not impose an additional multibillion-dollar pollution control program without first determining with some assurance that the intended environmental benefits will be achieved.

Currently, in an effort to reduce uncertainties so that meaningful and effective program options can be considered, EPA is working on a number of projects. EPA alone has committed more than $9 million in fiscal year 1982 just to its research efforts on acid deposition.

The three major areas of uncertainty toward which EPA's portion of the research program is directed are: the transport, transformation, and deposition processes; the effects of acid deposition; and assessments and policy studies.

I have attached to my full statement a summary of the Agency's major research efforts in the acid deposition area. The funding levels listed with each area are approximate.

Over the next 3 to 5 years, we anticipate that many ambiguities and uncertainties will be reduced. Specifically, we expect to have the following information:

Additional studies of historical lake, stream, and reservoir data; status reports on acid-deposition effects on agricultural crops; a new report on the role of clouds and storm fronts in forming and scavenging acids in the atmosphere; the results of pilot tests and a completed demonstration of new combustion processes for controlling oxides of nitrogen and sulfur dioxide at significantly reduced costs; a summary report on the quantitative impacts of acid deposition on materials; additional results from Europe on forest productivity; a progress report by the National Oceanic and Atmospheric Administration on acid rain in remote locations; an aquatic model for predicting the rate of acidification occurring in lakes; second-generation models for predicting the transport and deposition of sulfur and nitrogen over long distances; and field studies validating laboratory experiments of the effects of acid deposition on selected major crops.

Because transboundary air pollution is a global concern, the United States signed an instrument accepting the United Nations Economic Commission for Europe Transboundary Air Pollution Convention on November 5, 1981. Moreover, with the August 5, 1980, memorandum of intent on transboundary air pollution, Canada and the United States agreed to begin cooperative steps to deal with transboundary air pollution and to develop a bilateral agreement. Formal negotiations were held in June and November this year and another meeting is planned for February 1982.

Within this structure, work groups are reviewing and evaluating currently available information. The work groups are comprised of representatives from EPA; the Departments of State, Agriculture, Interior, and Energy; the Council on Environmental Quality; the National Oceanic and Atmospheric Administration; and other agencies as well as representatives from corresponding Canadian departments. Interim work group reports are currently being reviewed.

H.R. 4830, by Mr. Gregg, would amend the acid precipitation task force structure and plan required under the Acid Precipitation Act of 1980. As indicated earlier, the Acid Precipitation Act of 1980 requires that a 10-year interagency research plan be drafted and submitted to the Congress. Additionally, the act requires that the task force prepare and present to the Congress annual reports of its research activities and recommendations for further research or other actions.

The Gregg bill recognizes the requirements of the Acid Precipitation Act and seeks to refocus the existing program to accelerate research with a greater emphasis on remedial action.

The Gregg bill is generally consistent with the administration's approach to review of the Clean Air Act, for we join those calling for accelerated research to resolve the many uncertainties that surround this complex problem.

Many basic elements of the bill have already been incorporated in the interagency task force effort, either statutorily through title VII of the Energy Security Act or administratively through the operations of the task force. As I noted earlier, the task force is already required to transmit to the Congress annual reports giving the status of research efforts and any recommendations warranted.

The Administrator of EPA has authority to recommend actions to the President and the Congress which are warranted for protection of public health and the environment. We feel that existing reporting requirements are adequate. While we believe the approach underlying H.R. 4830 is consistent with our current effort, the mandated role of the National Academy of Sciences and the additional mandatory reporting deadlines may result in unnecessary duplication and, therefore, should be reviewed in light of existing reports and requirements.

H.R. 5055, by Mr. Rahall, would amend the Energy Security Act and change the 10-year program mandated by that legislation to a program with a 5-year duration.

Mr. SCHEUER. We are running well over the 5 minutes. I do not want to limit you, but I wonder if you could begin to summarize your testimony.

Ms. BENNETT. I will summarize the summary, Mr. Chairman.

Let me be sure to address the Rahall bill, and then I will summarize.

We support Mr. Rahall's desire to accelerate research to resolve the uncertainties associated with acid deposition; however, we do not feel that the task force's efforts should be legislatively accelerated to a 5-year program rather than the currently mandated 10-year program. The administration recognizes that it is important that research data be gathered and analyzed as soon as practicable and is strongly committed to do so. Limiting the research program to 5 years could require the termination of our efforts before the final results are realized.

I believe that the additional authorities recommended in this legislation would be duplicative and unnecessary.

As we have indicated, there are major uncertainties in many critical areas, particularly the transport and transformation of possible precursor emissions, the effects of acid deposition, and the policy implications of controlling acid deposition. In passing the Acid Precipitation Act of 1980, Congress itself established a comprehensive intergovernmental and interdepartmental research plan so that the complexity of acid deposition could be more fully addressed.

In view of the many fundamental scientific uncertainties; the possible substantial cost burden of additional controls; the extensive congressional involvement, including the 10-year directive to investigate the problem; and the fact that current research is expected to provide us with better data and guidance, we look forward to fulfilling the perceptive, realistic, and multidisciplined approach of Congress, as embodied 18 months ago in title VII of the Energy Security Act.

Thank you, Mr. Chairman.

[The prepared statement of Kathleen M. Bennett follows:]

STATEMENT OF
KATHLEEN M. BENNETT
ASSISTANT ADMINISTRATOR FOR AIR, NOISE, AND RADIATION
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURAL
RESEARCH AND ENVIRONMENT
OF THE
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

DECEMBER 9, 1981

Good morning, Mr. Chairman and members of Subcommittee. I am Kathleen M. Bennett, Assistant Administrator for Air, Noise, and Radiation of the U.S. Environmental Protection Agency. I am pleased to appear before you today to discuss the Agency's views on acid deposition, and in particular, H.R. 4830, the "Acid Rain Research Implementation Act of 1981 and H.R. 5055, the "Acid Precipitation Accelerated Review and Reporting Act." Acid deposition has become an issue of increasing global interest in recent years, and a matter of concern to the Administration and to Congress.

Acid Deposition--Knowledge and Uncertainties

"Acid deposition" is a general term for the deposition of acidic materials, whether wet or dry, from the air onto the surface of the earth or upon structures or objects.

Acid deposition occurs in varying degrees of severity in several parts of North America. However, the circumstances of its formation, the nature of its effects under various conditions, and the feasibility of potential controls are the subject of considerable debate. The question of appropriate remedial action therefore remains very uncertain.

Currently, we have considerable information on some aspects of the emissions of oxides of sulfur and nitrogen which can be the precursors of acid deposition. The majority of man-made emissions of sulfur oxides in the United States comes from utilities; the remainder comes from other combustion sources, non-ferrous smelters, and transportation sources. U.S. nitrogen oxide emissions come mainly from transportation and from utilities and industrial boilers.

We know that emissions tend to be highly interactive, and that multiple emissions must be considered simultaneously.

Both sulfur and nitrogen oxides can be transformed into sulfuric and nitrogen acids by reacting with moisture as well as other substances in the atmosphere. These transformations can take place in cloud or rain droplets or after deposition. Depending on a number of variables, emissions may be deposited relatively near their sources or transported over long distances.

Despite what is known about acid deposition, a number of major uncertainties in our current thinking remain to be resolved.

One uncertainty has been the pH level at which precipitation should be considered "acid." The conventional definition is based on pure water saturated with atmospheric carbon dioxide. It has a pH of 5.6, which is, therefore, the theoretical level of "normal" rainfall. Naturally occurring precipitation may be considerably more or less acidic.

Although oxides of sulfur and nitrogen are precursors of acid deposition, the transformation processes are still not understood. While there are significant differences in the composition and acidity of rain between seasons, geographical regions, and even during and between storms, no clear evidence is yet available which can explain or predict accurately how precursors are transformed or why the observed variations occur.

Yet another uncertainty exists with regard to the transport and distribution of precursor emissions. Remote regions of the globe have rains with a low pH, as do Hawaii and Alaska, and there is controversy over the role that localized emission sources may play. To resolve such controversies, both better data and more accurate modeling techniques are necessary.

Additional uncertainties for which we need better data include the relative impact of local sources as compared to more distant sources; the role of other photochemical pollutants and how they affect acidity levels; and the relative importance of the potential effects from acid deposition on different receptors (i.e., aquatics, forests, materials, etc.).

Need For Responsible Action

Any remedial action must be based on reasonable certainty that it will, in fact, accomplish its intended purpose. The American people have the right to expect that their government will not impose an additional multi-billion dollar pollution control program without first determining with some assurance that the intended environmental benefits will be achieved.

In this case, quick and simple solutions are unlikely. Given the length of time it has taken to recognize the magnitude and complexity of the problem and the many fundamental questions that remain to be answered, Congress wisely authorized a comprehensive research program.

Currently, in an effort to reduce uncertainties so that meaningful and effective program options can be considered, EPA is working on a number of projects.

EPA alone has committed more than $9 million in Fiscal Year 1982 just to its research efforts on acid deposition.

The three major areas of uncertainty toward which EPA's portion of the research program is directed are:

(1) transport, transformation, and deposition processes;

(2) effects of acid deposition; and

(3) assessments and policy studies.

I have attached to my statement a summary of the Agency's major research efforts in the acid deposition area. The funding levels listed with each area are approximate.

Other Federal Acid Deposition Research Activities

In 1980, Congress passed the Acid Precipitation Act. It established an interagency Acid Precipitation Task Force to prepare a ten-year comprehensive research plan to identify the causes and effects of acid deposition. Congress directed that annual reports be submitted which "detail the progress of the research program under this subtitle and... contain such recommendations as are developed."

The interagency effort under the Acid Precipitation Act began full operation in Fiscal Year 1982. The comprehensive research plan, entitled the National Acid Precipitation Assessment Plan, is currently being updated to incorporate public comments. EPA has been designated as the "lead agency" for three of the research areas: aquatic effects, control technology, and data assessments and analysis.

Furthermore, the results of research from all sources, public and private, are compiled and evaluated in assessments that provide research support for regulatory decisionmaking.

Anticipated Research Results

Over the next three to five years, we anticipate that many ambiguities and uncertainties will be reduced. Specifically, we expect to have the following information:

- Additional studies of historical lake, stream, and reservoir data.
- Status reports on acid deposition effects on agricultural crops.
- A new report on the role of clouds and storm fronts in forming and scavenging acids in the atmosphere.
- The results of pilot tests and a completed demonstration of new combustion processes for controlling oxides of nitrogen and sulfur dioxide at significantly reduced costs.
- A summary report on the quantitative impacts of acid deposition on materials.
- Additional results from Europe on forest productivity.

- A progress report by the National Oceanic and Atmospheric Administration on acid rain in remote locations.
- An aquatic model for predicting the rate of acidification occurring in lakes.
- Second-generation models for predicting the transport and deposition of sulfur and nitrogen over long distances.
- Field studies validating laboratory experiments of the effects of acid deposition on selected major crops.

Global Transboundary Air Pollution Activities

Because transboundary air pollution is a global concern, the United States signed an instrument accepting the United Nations Economic Commission for Europe Transboundary Air Pollution Convention on Nov. 5, 1981. Moreover, with the August 5, 1980, Memorandum of Intent on Transboundary Air Pollution, Canada and the United States agreed to begin cooperative steps to deal with transboundary air pollution and to develop a bilateral agreement. Formal negotiations were held in June and November of this year and another meeting is planned for February of 1982.

Within this structure, Work Groups are reviewing and evaluating currently available information. The Work Groups are comprised of representatives from EPA; the Departments of State, Agriculture, Interior, and Energy; the Council on Environmental Quality; the National Oceanic and Atmospheric Administration; and other agencies as well as representatives from corresponding Canadian departments. Interim Work Group reports are currently being reviewed.

H.R. 4830, the "Acid Rain Research Implementation Act of 1981"

H.R. 4830, by Mr. Gregg, would amend the Acid Precipitation Task Force structure and plan required under the Acid Precipitation Act of 1980. As indicated earlier, the Acid Precipitation Act of 1980 requires that a 10-year interagency research plan be drafted and submitted to the Congress. Additionally, the Act requires that the Task Force prepare and present to the Congress annual reports of its research activities and recommendations for further research or other actions.

The Gregg bill recognizes the requirements of the Acid Precipitation Act and seeks to re-focus the existing program to accelerate research with a greater emphasis on remedial action.

Specifically, the bill would require the Administrator of the National Oceanic and Atmospheric Administration (NOAA) to report to EPA within twelve months following enactment of H.R. 4830 and also at least once every 24 months thereafter with a summary of research findings. Within 60 days after receipt of this report, the Administrator of EPA would be required to determine whether "any new measures are necessary to prevent, limit, and remedy the harmful effects of acid precipitation." This determination would be made in a report to the Congress and the President. If the Administrator of EPA determined that new measures were needed, recommendations for legislative or administrative actions necessary to implement such measures would be required to be included in that determination report. Within 180 days following EPA submittal of that report, the Administrator of EPA would be required to "issue proposed rules requiring measures to be taken that may help prevent, limit, and remedy the harmful effects of acid precipitation."

H.R. 4830 then would require the Administrator of EPA to let contracts to the National Academy of Sciences for the purpose of securing independent analysis of research results and proposed alternative control strategies. Additionally, the bill provides for the establishment and/or strengthening of national and international monitoring networks. Further the bill provides for the establishment of additional mechanisms for the exchange of information and cooperative analysis of research data and control strategies at the local, State, national, and international levels. Finally, the bill requires that "adequate consideration" be given to economic impacts (including approaches to cost sharing to minimize unforeseen or inequitable economic impacts on regions or economic sectors) that would result from control measures.

We find the Gregg bill to be generally consistent with the Administration's approach to review of the Clean Air Act, for we join those calling for accelerated research to resolve the many uncertainties that surround this complex problem.

Many basic elements of the bill have already been incorporated in the Interagency Task Force effort, either statutorily through Title VII of the Energy Security Act or administratively through the operations of the Task Force. As I noted earlier, the Task Force is already required to transmit to the Congress annual reports giving the status of research efforts and any recommendations warranted. The Administrator of EPA has authority to recommend actions to the President and the Congress which are warranted for protection of public health and the environment. We feel that existing reporting requirements are adequate. While we believe the approach underlying H.R. 4830 is consistent with our current effort, the mandated role of the National Academy of Sciences and the addditional mandatory reporting deadlines may result in unnecessary duplication and therefore should be reviewed in light of existing reports and requirements.

H.R. 5055, the "Acid Precipitation Accelerated Review and Reporting Act"

H.R. 5055, by Mr. Rahall, would amend the Energy Security Act and change the 10 year program mandated by that legislation to a program with a five-year duration. Under this proposal, a final report by the Task Force with its final recommendations would be required not later than five years after the date of enactment of the Energy Security Act.

Additionally, H.R. 5055 would require the Task Force to investigate the usefulness of pre-combustion treatment of fuels, and "inherently low-polluting combustion processes, such as atmospheric fluidized bed combustion and pressurized fluidized bed combustion." Finally, the bill would require the Task Force to consult with State agencies carrying out studies and research relating to acid deposition.

We support Mr. Rahall's desire to accelerate research to resolve the uncertainties associated with acid deposition; however, we do not feel that the Task Force's efforts should be legislatively accelerated to a five-year program rather than the currently mandated ten-year program. The Administration recognizes that it is important that research data be gathered and analyzed as soon as practicable and is strongly committed to do so. Limiting the research program to five years could require the termination of our efforts before the final results are realized.

Furthermore, the Task Force through its Task Groups on Control Technology and Assessments and Policy Analysis is already considering alternate combustion processes, precombustion treatment, and mitigation strategies. Thus, additional authority is unnecessary. Finally, H.R. 5055 would require the Task Force to consult with involved State agencies. Under authority granted in the Energy Security Act, the Task Force is already consulting with State agencies. Consequently, no additional authority is needed.

While we agree with the need to accelerate acid deposition research, we do not favor enactment of H.R. 5055 for the reasons outlined above. If legislation is determined to be necessary to accelerate the research program, we would be happy to assist you in drafting appropriate language.

Summary

Acid deposition is a concern of many Americans, one shared by the Congress and by the Administration. The depth of this concern should be reflected in public policies that are based on sound science.

As we have indicated, there are major uncertainties in many critical areas, particularly the transport and transformation of possible precursor emissions, the effects of acid deposition, and the policy implications of controlling acid deposition. In passing the Acid Precipitation Act of 1980, Congress itself established a comprehensive intergovernmental and interdepartmental research plan so that the complexity of acid deposition could be more fully addressed.

Without such a firm foundation on which to base our decisions on whether controls are necessary, in what areas and to what degree, any regulatory action at this time would involve substantial guesswork.

In view of the many fundamental scientific uncertainties; the possible substantial cost burden of additional controls; the extensive Congressional involvement, including the ten-year directive to investigate the problem; and the fact that current research is expected to provide us with better data and guidance, we look forward to fulfilling the perceptive, realistic, and multi-disciplined approach of Congress, as embodied 18 months ago in Title VII of the Energy Security Act.

This concludes my prepared statement. I would be happy to respond to any questions you may have.

ATTACHMENT

Major EPA Research On Acid Deposition

To reduce uncertainty in the area of transport, transformation and deposition processes, we are studying the following:

- $800,000 for research on consolidating and reconciling current oxides of sulfur and nitrogen emissions information. This will create a data base that can be used to show a more accurate pattern of the magnitude and geographic distribution of man-made sources of these pollutants. We will be able then to improve our predictive capabilities, particularly with regard to major emissions sources.
- $800,000 for systematic data collection and monitoring studies of deposition and for associated research to increase the data on trends in deposition, and to improve monitoring techniques for both wet and dry acid deposition.
- $3,100,000 for atmospheric process research to obtain a better understanding of the actual mechanics of atmospheric transport, transformation, and deposition.

In order to gain a fuller understanding of the effects which may result from acid deposition, our efforts include:

- $100,000 for health effects impact studies on the effect of acid deposition on drinking water supplies, surface water, and groundwaters.
- $250,000 on materials research to determine the portion of material corrosion attributable to acid deposition

rather than to ambient air pollutants or other sources. This will also investigate the extent and aggregate cost of such damages.

- $1,400,000 for aquatic research to estimate the total number of lakes affected by acid deposition, as well as the sensitivity of streams and lakes to acidification, and the rate at which acidification actually occurs. In addition, these water quality measurements must be integrated with improved data on the impact of acid deposition on fish and the food chain, in order to develop information for possible short-term and long-term preventive and restorative measures.

- $1,300,000 for terrestrial studies on acid impacts on forest soils and trees, on soil nutrients, on leaching processes, and on soil chemistry changes. Both laboratory and field studies of acid deposition impacts on agriculture and major U.S. crops are also scheduled.

We are taking a broad look at possible policies and strategies, nd their implications.

- $1,300,000 for assessments and policy studies which will identify possible research avenues leading to potential mitigation strategies. Those options will then be analyzed considering the weight of existing scientific knowledge, costs and benefits, geography, degree of effectiveness, and other factors.

Mr. **Scheuer**. Thank you very much, Ms. Bennett.

Dr. Byrne, we have a rollcall vote and we will have to leave in about 7 minutes. So I suggest that you give us your testimony and then we will recess for the rollcall vote and then come back and ask you all some questions.

Dr. **Byrne**. Thank you, Mr. Chairman, for the record I am John C. Byrne, Administrator of the National Oceanic and Atmospheric Administration. Insamuch as the testimony is already in the record, I will take only a few minutes to give you some informal comments. If you will tell me when 3½ minutes are up, perhaps we may even have time for questions before the recess.

My colleagues have addressed the adequacy of the present task force. I would add that the participants from NOAA think that the task force is working well. We have a plan, which is presently in draft form, that will be published early this coming spring.

NOAA's serves as a lead agency for the lead on this task force with respect to several elements of research. There are a number of questions which should be answered before regulations are imposed. Of basic concern is the track that acid precursors follow from their point of origin to the point of deposition where they actually create a problem in the environment.

One of the things with which we are particularly concerned is the balance between manmade constituents and those which occur naturally. This is of particular concern as we address the occurrence of acid rain in remote areas where it is clear there is not a local source of acid precursors.

A considerable amount of research has been done in these areas and is adequately documented in the written testimony which you have.

In the remaining time I would like to comment briefly on both H.R. 4830 and H.R. 5055. On the question of H.R. 4830, NOAA would defer to EPA with respect to the desirability of the enactment of this legislation. We agree with our colleagues that much of the material in that bill is covered under the work of the present task force. We question, however, the need, as set up in the bill, for a contract with the National Academy of Sciences for monitoring activities. This, however, is not a major concern.

Before leaving that particular bill I would also mention that the bill refers to eliminating acid precipitation. We think that is a bit optimistic. We might prefer the term "minimize".

Finally, the bill points to a lack of consistantly analyzed data. To be more accurate, the scientific community would agree to a statement which refers to a lack of consensus on interpreting the data.

With respect to H.R. 5055, we have no particular problem with the general thrust of the bill. We do have a few points, however, which might help to clarify the intent of the bill.

The 5-year requirement should begin from the date of enactment of this bill rather than from the enactment of the Energy Security Act. We feel that 5 years is a minimum amount of time in order to obtain reasonable answers for a number of the very complex questions which are involved. Naturally, information will be provided as we go.

The final report might be referred to as an interim report inasmuch as it is very clear that we will not have a final word on this research within the 5-year period. We agree with all those in this room who believe that the acid rain problem is a serious one to the United States as well as to other nations. We also believe that research is the key to the solution of this problem and to the wise use of regulations aimed at its control.

Thank you, sir.

[The prepared statement of Dr. Bryne follows:]

STATEMENT OF DR. JOHN V. BYRNE
ADMINISTRATOR
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
ON ACID PRECIPITATION
BEFORE THE
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE
RESEARCH AND ENVIRONMENT
COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES

DECEMBER 9, 1981

Chairman Scheuer and Members of the Subcommittee;

I am pleased to be here to discuss two subjects related to the acid precipitation problem. One is the role that the National Oceanic and Atmospheric Administration (NOAA) plays in the nation's research on acid rain. The second subject is H.R. 4830, the "Acid Rain Research Implementation Act of 1981", a bill intended to strengthen research and development programs directed at understanding the causes and effects of acid precipitation, and to establish a cooperative process for developing strategies to control this environmental problem.

INTRODUCTION

Measurements of acid deposition east of the Mississippi have created the impetus to understand the potential effects of acid rain on the environment and have generated concern over potential adverse effects. Most of the information available at present concerns the impacts of increased acidity on the aquatic environment, particularly fresh water organisms. The increasing acidity of lakes and the corresponding decrease in freshwater fish populations are well documented. Freshwater spawning of ocean fish may also be affected by the increase of acidity in rivers in the Northeast. Other effects of acid rain are considerably less well documented than aquatic effects. The potential impacts include changes in crop and forest productivity, alternation of soils, and increased corrosion of metals and weathering of man-made structures.

The bulk of the man-made emmisions of the acid precursors (mostly sulfates and nitrates) are from areas upwind of regions where acid rainfall is observed. Since man-made emissions of suspected acid precursors have increased in recent decades, it has been inferred that the United States has largely created its (and perhaps some of Canada's) acid rain "problem". Furthermore, based on projected emissions it is feared that the situation will necessarily worsen producing perhaps irreversible losses in the years ahead as population and fossil fuel consumption increase.

Research is needed to determine the link which may exist between man-made emissions and acid precipitation and to establish the contribution which natural sources make to acid rain.

The following items represent a sample of some of the acid rain questions which must be answered through research:

- What is the origin of the acid precipitation which has been detected in extremely remote regions of the world? Is it due to the long-range transport of man-made materials or to local natural processes?
- How reliable may source location be linked to an area where acid precipitation occurs since complete data are not available concerning individual trajectories and the chemical behavior along them?
- How much do the limitations of the existing transport and air chemistry models impair the reliability of predictions?
- What is the magnitude of dry deposition? (Existing measurements have addressed primarily the acidity of wet deposition.)
- How important are natural sources as contributors to high acidity in lakes?

NATIONAL ACID PRECIPITATION RESEARCH PLAN: NOAA's Role

In passing the Energy Security Act (P.L. 96-294), Congress took into consideration the potential seriousness of the acid rain phenomenon, and the lack of key information on which necessary management decisions might be based. Title VII of the Act provides for establishment of a National Acid Precipitation Assessment Program together with a mandate for a comprehensive and accelerated effort to understand the cause and effects of acid rain. The Act also established an Inter-agency Task Force on Acid Precipitation to be responsible for planning and implementing the National Program and preparing a National Acid Precipitation Plan (the National Plan). The Task force is jointly chaired by EPA, NOAA, and USDA. NOAA has been assigned the role of Director of Research for the National Program. In fact, NOAA's role in the entire acid precipitation issue is that of providing scientific research into the atmospheric processes involved. This research will be made available to the agencies with regulatory responsibilities, primarily EPA.

The National Program includes research on emission sources, atmospheric processes, impacts, control strategies, and monitoring activities. The National Program's primary goal is to develop more knowledge on which sound energy and environmental policies may be established. To assist in the preparation of the mandated National Plan, NOAA has provided working members, as well as an Executive Director for the Interagency Task Force, furnished chairmen for the two technical research task groups for which NOAA has been designated as lead agency (i.e., natural sources and atmospheric processes), and provided NOAA scientists to serve on the other task groups.

The Task Force prepared a draft National Plan, which is now undergoing final revision, and is expected to be completed early next year.

The National Plan analyzes the current understanding of the acid rain phenomenon and its consequences; proposes a research program to obtain additional information; and outlines a management and coordination organization to make recommendations on possible future courses of action. The National Plan incorporates the results of previous Federal planning and research efforts. Furthermore, it calls for communication and cooperation with relevant non-Federal (state and local governmental agencies, universities, industry, private contractors, and research institutions) and international agencies or groups which are active in acid rain research.

The Task Force has grouped the needed acid rain information into nine key research categories. For each category a lead agency is designated and charged with the responsibility for program planning and coordinating the research activities of the Task Force with other Federal and non-Federal acid rain efforts.

On the international side, in response to both United States and Canadian concerns about acid rain, both governments signed a Memorandum of Intent in August, 1980. The Memorandum notes that the two countries have set a high priority for research that will provide a scientific understanding of long-range transport of air pollutants and resulting environmental effects, and for developing and implementing policies and technologies to combat such effects. The National Program will support our efforts to negotiate a treaty with Canada governing acid precipitation. Toward this end, NOAA has provided both a Subcommittee Chairman and working members for the U.S. Coordination Committee, which works with the Canadians on trans-border air pollution problems.

NOAA RESEARCH

NOAA's Laboratories for some time have been pursuing answers to some practical questions associated with the acid rain issue. We are involved in monitoring precipitation at various locations in the U.S. and around the world. Our scientists are trying to understand the complex chemical and physical processes that interact to transform acidic materials into acid rain. They are also developing and refining trajectory models that are needed to predict the transport and dispersion of pollutants from the various sources to the areas of deposition.

NOAA's Air Resources Laboratory, in cooperation with the World Meteorological Organization and EPA, carries out weekly precipitation sample collecting and analysis for ten regional sites in the contiguous United States to provide information on National acid precipitation trends. In addition, NOAA provided support to establish several remote world-wide sites that, in cooperation with local investigators, furnish data on the possible global distribution of acid rain.

In the past, it was assumed that the atmosphere in remote areas was so lacking in trace substances that the acidity of precipitation would not be high (i.e., have a low pH). (Normal rainfall has a pH of 5.6 on a logarithmic scale where every numerical decline represents 10-fold increase in acidity). However, there is now evidence that this assumption about remote areas is not always correct. One of the remote areas long used to study atmospheric chemistry is the Island of Hawaii, a location far removed from continental sources which might contribute to acid precipitation. NOAA scientists have collected rain samples at various sites on the Island of Hawaii since 1974. The elevations of the sites ranged from sea level to 3400 m. Samples were analyzed on the day of collection for pH and conductivity. Detection of major anions (negatively charged ions), such as sulfate and nitrate, was made from selected samples. Preliminary analysis of the data shows a progressive increase of acidity with elevation. The precipitation at the sea level site averaged a pH of 5.2 in contrast to the sites above 2500 m, which averaged a pH of 4.3 with some rains well below 4.0. It is postulated that the increase in acidity at higher levels might be due to acidic materials, either natural or man-made, being transported over long distances in the mid-troposphere (about 8 km above the earth's surface) and coming down in the rain of the Hawaiian Islands.

Another project has also provided new evidence on the transport and deposition of acidic materials. Analysis of rainfall at Bermuda, a site remote from man-made sources of acidic materials, has shown evidence of high acidity, at times as acid as in eastern North America. NOAA scientists have made calculations of the trajectories of airflows associated with acid rains in Bermuda. Their preliminary results indicate that the more acidic rainfalls came from eastern North America. This suggests that the acidic materials can be transported over very great distances.

Comments on H.R. 4830

The bill you are considering today (H.R. 4830) would require the Administrator of the Environmental Protection Agency (EPA), assisted by the Secretary of Agriculture and the Administrator of the National Oceanic and Atmospheric Administration (NOAA), to make determinations of whether any new measures are necessary to prevent, limit, and remedy any harmful effects of acid precipitation. In addition, they would be responsible for ensuring that the National Plan is structured and supported to satisfy the purpose and policy of the bill. If the Administrator of EPA determines that new control measures are necessary after consulting periodically with the Task Force, the National Academy of Sciences and others, the Administrator shall propose rules for such measures.

NOAA defers to EPA on the desirability of the enactment of this legislation. However, I have some general comments to make on this bill.

The provisions of the legislation duplicate many of the activities of the Interagency Task Force that I described earlier in my testimony. Research to obtain much of the required data is underway, and plans for further national activities are in preparation by the Task Force. The bill also would require a report on the status of the research program. This requirement can be readily fulfilled by the annual report of the Task Force.

We question the need for a study contract with the National Academy of Sciences as provided for in the bill. The Task Force has a mechanism to coordinate and review its plan and program on a timely basis. These activities include workshops with expert scientists and engineers. Therefore, it should not be necessary to require contracting for another committee to review the work of the Task Force.

I should also mention that in several places the bill refers to eliminating acid precipitation. "Minimize" is a more realistic word. In addition, reference to "other pollutants" should be deleted because the bill is directed at the acid precipitation problem. Finally, I believe that the "Finding" that there is a "lack of consistent analyzed data" should be more accurately stated as "a lack of consensus on interpreting data."

In summary, acid rain is a problem of serious concern to the U.S. and other nations. Research is needed to provide the basis for us to take additional necessary actions to deal with acid rain. NOAA is prepared to use our expertise in atmospheric chemistry, meteorology, and oceanography to continue our research into this phenomenon and we will work with all of the governmental agencies and industries involved in an effort to help come up with answers to this problem.

Thank you, Mr. Chairman, for the opportunity to appear before you today. This completes my statement. I would be happy to answer any questions the Subcommittee may have on the NOAA role in acid precipitation research or on the proposed legislation, H.R. 4830.

Mr. **Scheuer**. Well, you certainly did complete your testimony in 5 minutes or less, and I appreciate that very much, very succinct and very well thought through.

I think we ought to suspend now for about 12 or 13 minutes and then we will be back to ask you some questions.

Thank you.

[Recess.]

Mr. **Scheuer**. My colleague from Rhode Island.

Mrs. **Schneider**. I would like to direct this question to Ms. Bennett. I wonder if the information on EPA's funding for acid rain study for fiscal 1981, what the information is that you already have on EPA's funding for fiscal 1981 as compared to what 1982 might be?

Ms. **Bennett**. The EPA numbers were $7.2 million authorized for 1981. The number for fiscal 1982 is $9 million, and so there has been an increase in research and development dollars devoted to the acid rain question.

Mrs. **Schneider**. Do you have some figures now that you are anticipating for 1983?

Ms. **Bennett**. No, I do not. Those are still being developed.

Mrs. **Schneider**. And are there funds that are provided only by title VII or will EPA provide additional funds?

Ms. **Bennett**. There are many sources for funding due to the diverse nature of the projects that are underway throughout the Government for funding this area.

Mrs. **Schneider**. So it would be a combination of funds not only from your agency but from NOAA and the others?

Ms. **Bennett**. That is correct. For fiscal 1982 the governmentwide number is in the range of $18 million.

Mrs. **Schneider**. Good. Thank you very much.

I have no further questions, Mr. Chairman.

Mr. **Scheuer**. Thank you.

Dr. Byrne, on pages 4 and 5 of your testimony you indicate that the national plan will outline a management and coordination organization to make recommendations on possible future courses of action. Can you tell us when this organization will be formed and what will comprise it?

Dr. **Byrne**. Yes, sir. The plan should be available early this spring, conceivably even sooner than that. At this time, I cannot give you specific details concerning the plan, but I can provide you with a prior copy, if that would be suitable.

Mr. **Scheuer**. We would appreciate that very much.

Mr. Hill, was it you who mentioned that the comprehensive research plan that was mandated by the 1980 Acid Precipitation Act was due sometime next spring?

Mr. **Hill**. I could have mentioned that. I know, Mr. Chairman, because CEQ houses the staff of the task force, that the plan is in final draft form now, it is about to go out for the last final review and comment, and then it will go to the printer.

Mr. **Scheuer**. So it ought to be out before the spring?

Mr. **Hill**. It will be out as soon as we can get it.

Mr. **Scheuer**. We are concerned about this because it was due in April of 1981 and what we are looking at is a delay of 7 or 8 months now and a further delay of over a year if we do not get it until next spring.

This is just in designing the research plan, not even doing the research, and we are afraid of this time gap getting larger and larger and larger.

Mr. HILL. Ms. Bennett, I think, referred to research that is already under way that will fit within that plan.

Mr. SCHEUER. Yes, sir. When it is ready to go out to the printer and has been completely signed off by everybody, could you send us a copy, whether it is mimeographed or typed or whatever, so that we will have a chance to start looking at it before the printing process is approved?

Mr. HILL. Surely.

Mr. SCHEUER. Mr. Hill, you mentioned that the working group of the Cabinet Council on Natural Resources and Energy is formulating administrative policy on acid rain, is that correct?

Mr. HILL. That is correct.

Mr. SCHEUER. Can you tell us who sits on this group and how many times they have met and the mechanism by which this group is kept apprised of the latest research findings in acid rain?

Mr. HILL. I think because we have multiple interrelationships, for instance, take the CEQ situation, CEQ is on this group. It is also on the negotiating team under the Memorandum of Intent for our negotiation treaty with Canada and is also on the Research Task Force.

Now, the member agencies are the Council, EPA, Interior, Commerce, Agriculture, the Council of Economic Advisers, State Department, Office of Management and Budget and Office of Policy Development. So we tried to cover the waterfront.

Mr. SCHEUER. And you said because of something and you never gave us the end of the sentence. I asked you who sits on it and how many times it has met. And by what process are they going to be kept apprised of the latest research findings on acid rain?

Mr. HILL. They will be kept advised through the Council on Environmental Quality. The members of this group are policy level people exclusively. The Research Task Force, on the other hand, are scientists, scientifically oriented people. So the Council will function as that coordinating mechanism which is one of the reasons for forming the working group.

Mr. SCHEUER. How many times has the Council met?

Mr. HILL. Our working group has met at least 6 times.

Mr. SCHEUER. When did you say the Council is going to report?

Mr. HILL. Well, the Council will then report when we have sufficient information in hand; we will recommend control steps necessary as the scientific base on which to make a decision is there. That will flow through the Cabinet Council to the President.

Mr. SCHEUER. When do you think that first set of recommendations will be ready?

Mr. HILL. As soon as we have the research data.

Mr. SCHEUER. Well, you are not talking about 5 years, are you?

Mr. HILL. No. That is correct.

Mr. SCHEUER. What kind of timeframe are you talking about?

Mr. HILL. I would hope much sooner than 5 years.

Mr. **Scheuer**. Are you going to make any recommendations that it would be appropriate to take regulatory action based on our current knowledge base, the current state of the——

Mr. **Hill**. No. The working group has recommended that we hold to the position we have at this point which is we could not have sufficient scientific information on which to make a decision at this time.

Mr. **Scheuer**. And has this Cabinet Council delineated the further research that has to be done?

Mr. **Hill**. That will come from the work of the task force. We do not feel the work of the task force should be duplicated any other place.

Mr. **Scheuer**. Well, that is fair enough.

Can you give us any idea of timeframe. I have a sort of queezy feeling that I am trying to punch my way out of a bag of wet Kleenex.

Mr. **Hill**. We are trying to get the scientists to work faster.

Mr. **Scheuer**. Faster than what?

Mr. **Hill**. Faster than they have been. I think the administration has taken a position that additional resources were needed for the research effort and additional resources have been requested from the Congress and appropriated by the Congress.

Mr. **Scheuer**. Thank you, Mr. Hill.

Dr. Byrne, your testimony seems to indicate that acid rain in both Hawaii and Bermuda are due to long-range transport of manmade emissions. Is that a fair characterization?

Dr. **Byrne**. I think that is one of the interpretations of the data, yes, sir.

Mr. **Scheuer**. Is that a reasonable interpretation?

Dr. **Byrne**. I think so.

Mr. **Scheuer**. We are running terribly late and we still, unfortuantely have two panels to go. So I am going to ask unanimous consent that members be allowed to submit questions in writing to pass on to this panel, and I want to thank you for your patience and interesting testimony, and with that we will move on to the next panel.

Thank you all very, very much.

Ms. **Bennett**. Thank you, Mr. Chairman.

Mr. **Scheuer**. We will now ask Mr. Michael Oppenheimer and Mr. Thomas Decoster to come up to the table. Dr. Michael Oppenheimer has been a frequent witness before this subcommittee and he is always thoughtful and provocative. We look forward to his testimony. He represents the National Clean Air Coalition. Mr. Decoster represents the New Hampshire Task Force on Acid Rain.

As you can see from looking at the clock we are way behind schedule so, again, we will ask you both to stick to 5 minutes and we will have some questions for you and probably we will also submit other questions in writing.

Mr. **Scheuer**. Dr. Oppenheimer.

STATEMENTS OF MICHAEL OPPENHEIMER, NATIONAL CLEAN AIR COALITION; AND THOMAS DECOSTER, NEW HAMPSHIRE TASK FORCE ON ACID RAIN

Mr. **Oppenheimer**. Mr. Chairman, thank you for asking me once again to testify before this subcommittee. I am the senior scientist in the New York office of the Environmental Defense Fund and I am speaking today as a representative of both the Environmental Defense Fund and the National Clean Air Coalition.

I was invited to attend the Scientific Panel held here a couple of weeks ago and regretably I had to testify in another matter in New York. However, I have been involved in the acid rain problem for the last year or so and I have been involved in the evaluation of the work of the National Acid Precipitation Task Force.

Let me skip rapidly to give the bottom line of my testimony since it is the most relevant point.

I have been specifically requested to comment on H.R. 4830 and H.R. 5055. Both bills focus on research exclusively.

Now, I must say I agree with almost everything that Congressman Gregg said this morning and I was pleased to see the interest in this committee on the issue of acid rain. H.R. 4830 would essentially add tasks to the research mandate of the task force and require periodic reporting. As a companion to H.R. 4829, the Moffett-Gregg bill, which mandates a 10-million-ton reduction of sulfur dioxide emissions over the next decade, we have no objection to the provisions of H.R. 4830.

In fact, if the requirements are carried out they will add to our understanding of the acid precipitation problem over the long term which, as a scientist I certainly applaud. However, on behalf of the Clean Air Coalition I want to strongly emphasize that we cannot endorse H.R. 4830 by itself.

As I stated before, and this is my firm position, enough is known about the sources of acid rain to initiate a control program now. The research results from the current work being done pursuant to the Energy Security Act as enhanced by H.R. 4830 will help us to define additional control strategies which may be necessary in the future.

We cannot be supportive at all of H.R. 5055. We strongly disagree with several of the sections, including section 2(a) which states for instance that the causes and effects of acid deposition must be better understood before a control strategy is undertaken.

In addition there is some question as to whether a 10-year research program, accelerated to 5 years, would actually increase the rate of scientific understanding.

Just to be very brief and summarize the bulk of my testimony which is on the state of scientific knowledge, I firmly believe at this point that our understanding of the science is sufficient to warrant immediate regulatory action and I would like to say that I disagree with almost everything that Congressman Rahall said on the subject of the state of the science.

We know for sure that precipitation is much more acidic in this part of the country than it would be normally; that atmospheric loading of sulfur and nitrogen compounds share the major responsibility for the acidity; that approximately two-thirds of the total

U.S. sulfur loading is from powerplants, and that since nearly three-fourths of the acid in eastern U.S. precipitation is due to sulfuric acid, the utilities must bear the major responsibility for the acid rain problem in this part of the country.

I might add that in response to a comment on the fish kills mentioned earlier, a recent article by Dr. McLean expanding on the work of Dr. Johannes in the Adirondacks makes the point that the sulfates are probably nearly as important as the nitrates in the fish kill situation.

My own research is atmospheric research and I would like to briefly say that the state of our understanding of the atmospheric transformation has accelerated recently. There is a growing consensus in the scientific community that the sulfates are produced in situ in clouds and raindrops. My own research indicates that there is sufficient severely oxidant available so that this process is not severely oxidant rate limited or saturated and that the response of the atmosphere to reducing SO_2 emissions will be a significant reduction in sulfate output.

In other words, if we cut SO_2 emissions now by a significant amount, say on the order of half, we will achieve measurable benefits in the next few years.

I think I will just stop at that point.

[The prepared statement of Dr. Oppenheimer follows:]

ENVIRONMENTAL DEFENSE FUN

TESTIMONY OF DR. MICHAEL OPPENHEIMER

Before The

SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT

December 9, 1981

Mr. Chairman, my name is Dr. Michael Oppenheimer. I would like to thank you for the invitation to testify here today. I am the senior scientist in the New York office of the Environmental Defense Fund, a national non-profit organization dedicated to the preservation of the human and natural environment. I have recently joined EDF after ten years as an atmospheric physicist at the Harvard-Smithsonian Center for Astrophysics at Harvard University. The Environmental Defense Fund is a member organization of the National Clean Air Coalition, and I am speaking today as a representative of both EDF and the Coalition.*

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* The National Clean Air Coalition is composed of the following national organizations: American Lung Association; Center for Auto Safety; Citizens for a Better Environment; Environmental Defense Fund; Environmental Policy Center; Environmentalists for Full Employment; Friends of the Earth; International Association of Machinist and Aerospace Workers; Izaak Walton League of America; League of Women Voters of the United States; National Audubon Society; National Consumers League; National Farmers Union; National Parks and Conservation Association; National Wildlife Federation; Natural Resources Defense Council; Oil, Chemical and Atomic Workers; Sierra Club; United Steelworkers of America; The Wilderness Society; Western Organization of Resource Councils.

Mr. Chairman, I shall address the question of the extent of our scientific understanding of acid deposition. In my remarks today, I shall pay particular attention to the scientific evidence on the causes of acid deposition and their implications for an acid deposition control strategy. I shall also comment on the human health hazard attributable to the fine particles associated with this problem, an area which has received inadequate attention in recent discussions of acid rain. It is my position, as a scientist, that our understanding is sufficient to warrant immediate action on controls on the emissions which cause acid rain.

Here is an outline of the state of scientific understanding of acid rain:

(1) Precipitation over most of the eastern United States including the Southeast is abnormally acidic, ranging up to 20 to 40 times more acidic than normal on an annual average basis in parts of the Northeast.[1,2] Acid rain also has appeared in the Rockies[3] and is widespread in California.[4] Rainfall in the East is primarily a dilute solution of sulfuric acid while in the West it may be primarily either nitric acid or sulfuric acid.[1,3,4,5] There is no question that precipitation acidity substantially exceeds the natural background value.

(2) Atmospheric loading of sulfur and nitrogen compounds is by far the major source of acid rain. In eastern North America, atmospheric loading of sulfur and nitrogen due to human industrial

and transportation activity far exceeds that from natural sources. Natural sources of sulfur in the eastern U.S., much less than one million tons per year, are far too small to account for the sulfur, mostly in sulfuric acid, actually observed in precipitation, about three million tons per year. For comparison, man-made sources of sulfur amount to nearly 12 million tons per year[6, 7, 8] (equivalent to 24 million tons of SO_2). Approximately two-thirds of the total U.S. sulfur loading is from power plants, which also provide nearly 30% of the atmospheric loadings of oxides and nitrogen. Emissions from the transportation sector are another major source of oxides of nitrogen (NO_x), providing over 40% of the national total.[9] Since, on average, nearly three-fourths of the acid in eastern U.S. precipitation is due to sulfuric acid,[1] and since utilities are responsible for more than 70% of eastern U.S. sulfur emissions,[7,8] it is certain that utilities are the major source of acid rain in the East. The recently issued report of the National Academy of Sciences confirms this conclusion.

(3) The detailed mechanisms for the transformation of sulfur dioxide (SO_2) and NO_x emissions into acid rain are not completely understood, but there is absolutely no doubt that the transformation occurs. I have spent most of the past year researching this transformation. A general description of the process is the following: SO_2 and NO_x emissions from various sources are mixed into the lower atmosphere with moisture and other pollutants. Out of this chemical

soup, various nitrates and sulfates are produced, among them nitric acid and sulfuric acid. Some of this material is periodically rained out in precipitation and some remains suspended as fine particles. Many of these fine particles as well as untransformed sulfur dioxide molecules, are eventually deposited as dry acid material in a process called dry deposition. In many areas, dry deposition is a major sulfur deposition mechanism. Thus, the acid rain and fine particle problems are intimately related.

Let us examine the transformation process more closely. Substantial evidence has accumulated that nearly all SO_2 absorbed into droplets is converted to sulfates, 10/ mostly sulfuric acid, 1/ and that this process is the major source of precipitation sulfuric acid. 11,12/

Furthermore, recent studies indicate that considerable oxidant is available for the oxidation of sulfur dioxide in precipitation and cloud water, 13,14/ and that this process is not inhibited by decreasing pH. 15/ My own research indicates that this aqueous phase transformation process enables the level of sulfuric acid in precipitation to respond to changes in the level of atmospheric SO_2. In other words, substantial reductions in atmospheric SO_2 should lead to significant, although not necessarily equal, reductions in sulfuric acid in rainfall. Regardless of the details of the transformation processes, the results of both long-range transport modeling 15/ and precipitation monitoring networks 1/ are consistent with the notion that reducing atmospheric SO_2 through emissions reductions will lead to significantly lower levels of sulfur wet deposition , atmospheric sulfate particles, dry deposition and precipitation acidity.

I would like to emphasize that the SO_2 and NO_x which are not converted into acids in the atmosphere and deposited in rainfall are still a source of environmental damage. Unconverted SO_2 is eventually deposited on land, water, plants, and trees and much of this material is then converted to acid. Suspended fine particles present a health hazard when inhaled by humans. Much of the fine particulate matter is eventually deposited on leaves, soil, and surface water and, along with the dry sulfur dioxide, contributes perhaps an additional 30% to ecosystem acidification.[16/] Thus, almost all of the SO_2 originally emitted ends up on the earth's surface in one harmful form or another. In addition to a decrease in the acidity of precipitation, therefore, a decrease in SO_2 emissions will reduce environmental damage caused by dry deposition. The reduction in dry deposition of SO_2 will occur at least in direct proportion to the reduction in sulfur dioxide emissions.

(4) Long range transport plays a vital role in the distribution of acid rain, sulfur dioxide, and fine particles about the country. Recent atmospheric modeling summarized in the report of the Working Group on Atmospheric Modeling Under the U.S.-Canada Memorandum of Intent on Trans-Boundary Air Pollution [15/] and the Second Report of the U.S.-Canada Research Consultation Group on the Long-Range Transport of Air Pollutants [17/] provides a general picture of this process.

There is little doubt that most of the wet deposited sulfur including sulfuric acid reaching the Adirondacks, for instance, originates outside the Mid-Atlantic region, largely in the Ohio River Basin and the Upper Midwest. The contribution of U.S. sources to sulfur deposition in Canada is about equal to the contribution of Canadian sources to sulfur deposition in Canada. Furthermore, the U.S. contributes five times more to deposition in Canada than Canada does to deposition in the U.S. 15/

There has been at least one study widely circulated which purports to show that local sources in the Northeast constitute the main source of sulfates in that region. 18/ I have carefully studied this report by researchers at PEDCo Environmental, Inc., commissioned by the Department of Energy, and find that the assumptions made concerning the rate with which sulfur is transformed are without basis and at odds with the best scientific evidence. Using more reasonable assumptions, even the model used in that report would tend to substantiate the findings of the Working Group that 70% or more of the sulfate over the Adirondacks originates outside the local region. (The report, for instance, assumes a degree of sulfur transformation in power plant plumes which is three times larger than generally accepted.)

Further evidence of the significance of long-range transport comes from satellite photographs of pollution episodes combined with simultaneous ambient air measurements. 19/ These measurements show the large scale relationship of sulfates, ozone, TSP, and reduced visibility over the East. Trajectory analysis also has demonstrated that specific instances of atmospheric stagnation in the Midwest are correlated with enhanced sulfate levels at later times in the East. 20/ Research performed in conjunction with the SURE studies has confirmed the existence of long-range transport of sulfates. 21/ The reality and significance of long range transport is no longer in doubt.

(5) Historical data on precipitation acidity over the last 20-30 years is not of high quality. However, these data do suggest a relationship between the construction of taller stacks and the spreading out of the region of abnormally acidic rainfall. Precipitation pH data from the 1950's, even when corrected for the possible neutralizing effects of drought-generated dust, indicate a spreading of the region affected by acid precipitation, 22/ in spite of the fact that total U.S. sulfur emissions have not changed much. However, the fraction of emissions generated by utilities commonly emitting through tall stacks has increased markedly in the last several decades. 9/ Furthermore, the few measurements made in the 1930's indicate that rainfall in the Northeast was much less acidic at that time. 23/ A glance at a map of precipitation acidity in the U.S. clearly shows the intimate association of fossil fuel emission sources and abnormally acidic precipitation. 1,24/ Most significantly, recent studies 25,26/ indicate that the decrease of sulfur emissions in the Northeast over the last decade, has in fact been accompanied by a decrease in sulfate deposition levels, a fact which should lead us to anticipate the success of an emissions reduction strategy.

(6) Arguments have been made that low rainfall pH measurements at a few remote island stations [27/] mean that rainfall is normally very acidic. I would like to emphasize the complete irrelevance of this argument to the eastern U.S. where man-made sources of acidity far outweigh natural sources. Furthermore, some natural sources of sulfur are more significant for these island stations than for the U.S. mainland. Finally, these observations may simply indicate the importance of global transport of pollutants at certain locations since some remote stations report normal pH levels of 5.6.[27/]

In summary, it is certain that precipitation in the U.S. is now far more acidic than it would be in the absence of human activity. The primary source of this acidification, especially in the eastern U.S. is utility emissions, mainly of sulfur dioxide. There is now strong evidence that substantial reductions in utility sulfur dioxide emissions will lead to significant reductions in wet sulfur deposition, precipitation acidity and suspended sulfates. It is certain that the problems associated with sulfur deposition in its various forms cannot be solved without reductions of utility SO_2 emissions. However, mobile sources continue to be a significant component of this problem, and their relative importance will increase as utility emissions are reduced. Therefore, it is critical that tailpipe NO_x standards not be relaxed.

Let me now address the subject of health effects associated with this problem. It is particularly important that significant atmospheric sulfate level reductions can be expected to accompany an SO_2 emissions reduction program, given the human health implications of atmospheric sulfates. Sulfates, which occur almost entirely as fine particles, and are not separately regulated under the health standards of the Clean Air Act, are shown in some studies to be more damaging to human health than sulfur dioxide. Direct epidemiological evidence exists of health damage at sulfate levels which correspond to the regional component of Northeast ambient sulfates.[28] In other words, the interstate component of the sulfates may play a significant role in adverse health impacts of pollution. In addition, epidemiological evidence concerning sulfates was sufficient to convince California to enact a sulfate standard. The long range transport component of sulfates creates potential PSD increment consumption and ambient air quality maintenance and attainment problems in some areas and has been the subject of litigation among various states. Thus, we are concerned that the fine particles which are an integral part of the acid rain problem may be causing widespread health damage in the Northeast.[29]

Furthermore, SO_2, which is the original source of the sulfates, itself participates in long range transport in the Northeast. This component of SO_2 also contributes to ambient air standards maintenance and attainment problems in some areas, and thus potentially to health impacts. For instance, long range transport models indicate that less than one-third of the average SO_2 concentration in the New York State air is due to New York State emissions. In addition, synergistic effects of sulfates, zone and SO_2, all of which participate in long range transport, are little understood. What little evidence exists in this area is not encouraging.

My conclusion, as a scientist, is that enough is known about the sources of acid rain to initiate a long-term control program aimed at the abatement of emissions of sulfur dioxide and oxides of nitrogen. Since utility sulfur dioxide emissions are the major single source of the precursors of acid rain, these emissions should be the initial target of a control strategy such as that proposed by the National Clean Air Coalition. The potential for human health damage from fine particles, in addition to the documented damage to our natural environment, underscores the urgency of reducing current levels of nitrogen oxide and sulfur dioxide emissions.

I have been specifically requested to comment on the provisions of H.R. 4830, the bill introduced by Congressman Gregg, and H.R. 5055, the bill introduced by Congressman Rahall. Both bills focus exclusively on research into the causes and effects of acid rain, building on the present efforts of the Acid Precipitation Task Force set up under Title VII of the Energy Security Act.

H.R. 4830 would essentially add tasks to the research mandate of the acid precipitation task force and require periodic reports concerning whether existing control strategies should be modified. As companion to H.R. 4829, the Moffett-Gregg bill which mandates a ten million ton reduction of sulfur dioxide emissions over the next decade, we have no objections to the provisions of H.R. 4830. In fact, if the requirements are carried out they will add to our understanding of the acid rain problem over the long-term.

On behalf of the National Clean Air Coalition, however, I want to emphasize strongly that we cannot endorse H.R. 4830 by itself. As I stated before, enough is known about the sources of acid rain to initiate a control program now. The research results from the current work being done pursuant to the Energy Security Act and as enhanced by H.R. 4830 will help us define additional control strategies which may be necessary.

We cannot, however, be supportive of H.R. 5055. We strongly disagree with Section 2(a) which states, for instance, that the causes and effects of acid deposition must be better understood before a control strategy is undertaken. In addition, we have doubts whether requiring a ten-year research program to be completed in five years will actually accelerate our understanding of the acid rain program.

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Mr. **Scheuer**. Thank you very much.

Mr. **Decoster**. Thank you, Mr. Chairman, I appreciate the opportunity to speak here today and I feel in a large sense I represent the constituency of the entire Northeast rather than just my own home State of New Hampshire.

I am here today speaking on behalf of the Citizens' Task Force on Acid Rain. Before I came down here today, I went and had a long conversation with the people from the Water and also the Air Resources Board in the State of New Hampshire, as well as the Governor's appointee on the New Hampshire Acid Rain Coordinating Committee and, as my written testimony indicates, the opinions that I express here are the unanimous opinion of the consensus of all the environmental groups as well as the government agencies in my home State.

That is rather an astounding thing in itself, I think.

I would like to comment about Congressman Gregg's bill, H.R. 4830, first. I think the time frames that he suggests are reasonable and necessary. In my own home State of New Hampshire, when we talk about research, we have a research facility at Hubbard Brook which is the longest continuous record in North America of rain and snow chemistry. I think that is important. Looking way back to 1963, the Water Supply and Pollution Control has monitored pH since 1972 and they have discovered that there is a decrease of five-fold in this short period of time.

New Hampshire Fish and Game Department and also the water resources board has been monitoring lake and pond pH for over 40 years. Now we are talking about a long period of research. It may not be of the caliber that is now being suggested by this legislation, but it is certainly there and it does exist.

In reading the National Academy of Science report, I was very dismayed to read the quote that direct cause and effect linkages between the sources of acid rain and effects on the ecosystem will not be possible in the foreseeable future. However, I was somewhat heartened to see them identify some of the known causes right at this point in time and also to indicate that there was no reason whatsoever why we should not impose controls as suggested by the Mitchell bill in the Senate and the Moffett-Gregg bill in the House.

My sole purpose of being here today is to express the opinion that research is needed. There are areas other than SO_2 emissions which are of importance and we certainly endorse control of all sorts of emissions, not just SO_2 emissions. However, a research bill without a control bill is totally unacceptable to the public.

I have also recently read the Harris poll which clearly states the people not only in the Northeast, not those of us who are impacted directly, are willing to pay for the implementation of whatever is necessary to have clean air.

I have relatives. I am sure each of you have relatives who live in other parts of the country. I have relatives from New Hampshire to California. They are interested in my welfare as I am interested in their welfare. I think it is erroneous for those people who would like to see a slackening of controls or a long-term-research project that does not effectively address the controls now to suggest that their consumers are the ones who are concerned and unwilling to pay.

Mr. **Scheuer**. Let me just interrupt you briefly here and I will not do it again. Congressman John Dingell this morning addressed a number of his colleagues on this subject. He admonished them not to take the Harris poll too seriously, as it was a flawed poll because it just asks people, "Do you want cleaner air and do you want cleaner water?" and of course they would say yes, sir.

His feeling was they want cleaner water and cleaner air and enhanced environment but not at the cost of jobs, and that it was this flaw in the poll that the Harris people did not make clear, that advances were made in cleaning up the environment at a cost and that sometimes the cost was jobs.

That had not been made clear to the people in the poll. What is your response to that? I will ask Mr. Oppenheimer to respond to that, too.

Mr. **Decoster**. I think if I were a coal miner that I would be concerned about providing benefits for my family. I think there is no question about that. I think Congressman Gregg's bill addresses the problem of balancing out economic impacts and things of that sort and I think it perhaps is one of the most crucial aspects of the bill.

I think however, that I can only speak for myself. Were I in another part of the country where I knew that my employment caused the direct death or related health effects that caused the death of my relatives or my friends or people I did not even know in another section of the country, I might be looking for employment elsewhere.

I am not sure that the constituency at large is that conscientious, but I do not believe that the health and welfare of this entire Nation can be traded off against a few jobs in industries that mine coal, and so forth.

Mr. **Scheuer**. Mike?

Mr. **Oppenheimer**. It is my understanding by looking at studies done for the National Clean Air Coalition that on balance the total tonnage of coal mined in the Eastern United States will not be significantly affected by an acid precipitation control program. That study can be provided. Allegations that there will be massive shifts in coal demand resulting in significant job loss are not true.

[The study referred to follows:]

Cost and Coal Production Effects of Reducing Electric Utility Sulfur Dioxide Emissions

(Prepared for National Wildlife Federation and National Clean Air Coalition)

HIGHLIGHTS

The national costs of a 10 million ton reduction in the ARMS region would be $2.4 billion in 1990 and $3.4 billion in 2000. The costs increase over time because the price of lower sulfur coals increases with faster depletion of low-sulfur reserves resulting from increased low-sulfur production.

The average cost per ton of SO_2 removed in 2000 is about $350 per ton.

The marginal cost per ton removed in 2000 is about $550 per ton.

In the evaluation of various emission reduction proposals it is the marginal costs that should be compared to the marginal benefits.

Switches to low-sulfur coal are generally more cost-effective than scrubbers. Hence, the forecasts reflect a substantial shift to lower sulfur coals. With the inclusion of costs for upgrading particulate control systems (see above "Caveats") these shifts would be smaller.

Production, therefore, is forecast to increase in low-sulfur producing regions (e.g., Central Appalachia and the West) and decrease in high-sulfur producing regions (e.g., Appalachia and the Midwest).

Recall from the "Caveats" above that high-sulfur production is probably overstated.

The national least cost allocation of emission reduction results in about 85 percent of the 1990 ten million ton reduction occurring in the ten states listed: Illinois; Indiana; Kentucky; Michigan; Missouri; Ohio; Pennsylvania; Tennessee; West Virginia; and Wisconsin.

Correspondingly, over 90 percent of the 1990 total national costs from these reductions are forecast to be incurred in these states.

The various emission reduction liability schemes reallocate these costs somewhat. However, under the 1.2 lb.-30 day average approach and the 85 percent/1.7 lb.-30 day average approach, the share of costs incurred in these states in 1990 after buying and selling of emission reductions, would still exceed 90 percent of the total costs. Under the equal percentage approach, the 1990 share would fall to less than 50 percent.

In 2000, the cost allocation effects of the emission reduction liability schemes are similar.

Assuming buying and selling of emission reductions is institutionally feasible, the effect of the various emission reduction liability schemes is not to affect total costs but rather to reallocate costs between states. Thus, the choice of a particular scheme involves judgments regarding equity, implementation feasibility, and possible transaction costs. These were not addressed in this analysis.

Mr. SCHEUER. Yes, sir. Please continue, Mr. Decoster.

Mr. DECOSTER. I will sum this up very briefly. I think the importance of this issue is one that has, in effect, caused a Harris Poll that is quite accurate.

The Northeast damage report for April 1981, for example, concludes on page 62 that high levels of sulfate in the Northeast largely due to long-range transport into the region contributes significantly to the morbidity of the region, the probability of dying from air pollution related diseases is twice as high in the Northeast than any other region of the United States.

I think if you included that kind of conclusion in a national poll and you asked people if they were willing to pay a little bit more on the utility bill, I think the estimates run in billions of dollars and that obviously justifiably concerns those people who are put in a position of having to control their emissions. But I think if you asked the consumers, the people who ultimately pay, if you asked them I think they would indeed be willing to pay as they have to clean up water and to clean up other environmental messes that man has managed to get himself into.

I really do not think we have any choices. I think we are talking about the losses of our ecological systems eventually. No price is really too high to pay.

Thank you.

[The prepared statement of Mr. Decoster follows:]

STATEMENT OF THE CITIZENS' TASK FORCE ON ACID RAIN

To the members of the Science and Technology Committee; Natural Resources, Agriculture Research and Environment Subcommittee:

My name is Tom Decoster of Bedford, New Hampshire. I am here today representing the New Hampshire Citizens' Task Force on Acid Rain. We are a group of concerned citizens representing the membership of the Audubon Society of New Hampshire, Harris Center for Conservation Education, Loon Preservation Committee, New Hampshire Association of Conservation Commissions, New Hampshire Lung Association, New Hampshire Science Teachers Association, New Hampshire Wildlife Federation, Society for the Protection of New Hampshire Forests, the Manchester, New Hampshire chapter of Trout Unlimited, and others.

The State of New Hampshire also has a committee known as the New Hampshire Acid Rain Coordinating Committee, which consists of state resource agencies, legislators participating on resource committees, and the director of the Water Resources Research Center in Durham, N.H. The Acid Rain Coordinating Committee has also recently established a Technical Advisory Committee, whose membership consists of technical specialists from the Coordinating Committee who are familiar with the processes associated with acid rain.

The views I express here today represent a clear and unanimous consensus of the opinions of both our organizations.

Let me first consider the bill introduced by Congressman Gregg (H.R. 4830). We believe that unless a comprehensive research program is undertaken within a reasonably short time frame, the delay that results from a lack of understanding of acid rain may well be catastrophic to our environment.

The time frames provided for in H.R. 4830 are reasonable, if not heartening, to the people who will suffer the results of acid precipitation until we can control the problem. No one expects that we will be able to solve this situation overnight. In fact, to quote from the September 4, 1981 report of the National Academy of Sciences, "Direct cause and effect linkages between sources of acid and effects on ecosystems will not be possible in the foreseeable future, owing to the remoteness of sources and the complexity of the interaction among emissions from different sources, atmospheric transport, chemical transformations, and specific orographic and geological settings."

Statements like these are not encouraging, to say the least. So if we intend to do something about this problem, we had better start now.

Perhaps one of the more important aspects of H.R. 4830 is the provision that would address the problem of cost sharing and capital formation in order to "minimize unforeseen or inequitable economic impacts." Certainly we realize that the costs involved will run into billions of dollars each year, and that when numbers like these are suggested, utility companies, rate payers, and industrial giants tremble in their boots. The costs we must bear in order to properly address acid rain are high indeed, but we have no choice. If we fail to respond swiftly, the cost may well be the irreversible loss of the ecosystems that fish and fowl, animals, and we ourselves ultimately must depend upon for life. With the seriousness of this problem, regional differences must be dissolved, and we must share the necessary burdens that lie before us. When I think of these problems, my mind drifts to the picture of Earth, as viewed from space. This is "Spaceship Earth," and we do share the one and only environment it has to offer. We cannot afford the luxury of believing that our backyard is not an important part of the whole. In that respect, no price is too high and no burden too great to bear for survival.

All of that may sound quite melodramatic, but I really don't believe it is. We are already aware of massive losses of aquatic life, and the pending loss of thousands of bodies of water. The National Academny of Sciences reports that "many thousands of lakes have already been affected . . . At current rates of emission of sulfur and nitrogen oxides, the number of affected lakes can be expected to more than double by 1990, and to include larger and deeper lakes."

We know that the lower pH levels can disastrously change the mobility of toxic substances in the soil. To quote once again from the National Academy of Sciences report of September 4, 1981, "As magnesium and other elements are mobilized at low pH and leached from the soil, long-term permanent damage to the ecosystem may result, causing chronic deficiencies of the elements in plants. Also increased mobilization of ions could result in toxic concentrations of aluminum and manganese."

When faced with these life-threatening problems, there should be little question or doubt that sharing the costs involved in cleaning up the situation is something that ought to receive strong support. Let me conclude my comments on H.R. 4830 by saying that while we support and endorse the study of air quality problems, we do not believe that this bill should in any way be used as an excuse to delay the necessary and warranted control of emissions from known polluters. The National Academy of Sciences report states, "Although claims have been made that direct evidence linking power-plant emissions to the production of acid rain is inconclusive, we find the circumstantial evidence for their role overwhelming."

Such statements demonstrate the justification for immediate reductions in emissions of sulfur dioxide as proposed in the Moffett/Gregg bill (H.R. 4829) in the House, and the Mitchell bill (S. 1706) in the Senate. These two bills represent a good starting point in an effort to get this mess under control. To implement any research bill while avoiding immediate steps to control known sources of this problem would be totally irresponsible and unacceptable to the public.

My comments with regard to Congressman Rahall's bill should be easy to foretell by now. H.R. 5055 is just not enough of a response in a short enough time frame. To study a problem of this magnitude for five years before any action is taken would be irresponsible, when the National Academy of Sciences has concluded, "The picture is disturbing enough to merit prompt tightening of restrictions on atmospheric emissions from fossil fuels and other large sources such as metal smelters and cement manufacturers. Strong measures are necessary if we are to prevent further degradation of natural ecosystems, which together support life on this planet."

The Northeast Damage Report of the Long Range Transport and Deposition of Air Pollutants (April 1981) concludes on page 62 that, "High levels of sulfate in the Northeast, largely due to long range transport into the region, contribute significantly to morbidity in the region. The probability of dying from air pollution-related diseases is twice as high in the Northeast than in other regions of the United States."

These conclusions do not suggest that we have time to spend on the luxury of scientific certainty. To quote again from the National Academy of Sciences: "Direct cause-and-effect linkages between sources of acid and effects on ecosystems will not be possible in the foreseeable future," yet "the increased emission of sulfur and nitrogen compounds from anthropoganic sources is the only plausible explanation for acid deposition."

I have no objection to the suggestion that research is needed into the possibility of precombustion treatment of fuels in order to reduce sulfur dioxide and nitrogen oxide emissions, or the investigation of the potential of reducing such emissions by inherently low polluting combustion processes. I think these may provide some of the long range answers we need. The mere fact that Congressman Rahall includes these components as part of his bill, however, strongly suggests that he, as well as most of us, understands the source of many of our problems.

We need to act as swiftly as possible. Waiting for absolute proof is not the answer. I don't believe this point can be better illustrated than by the following quotes from the National Academy of Sciences report of September 4, 1981: "The committee believes that continued emissions of sulfur and nitrogen oxides at current or accelerated rates, in the face of clear evidence of serious hazard to human health and to the biosphere, will be extremely risky from the long-term economic standpoint as well as from the standpoint of biosphere protection." "Of the options presently available, only the control of emissions of sulfur and nitrogen oxides can significantly reduce the rate of deterioration of sensitive freshwater ecosystems. It is desirable to have precipitation with pH values no lower than 4.6 to 4.7 . . . this would mean a reduction of 50 percent in deposited hydrogen ions. Control of SO_2 from new electrical generating plants alone would be insufficient to accomplish this, and thus restrictions on older plants must be considered."

The only conclusions one can draw from the numerous reports available on the subject of acid precipitation is that a great deal of study is still needed about the many sources of our pollution problems. However, while this accelerated study process goes on, there is plenty of opportunity to control large sources of known pollution now. It doesn't take a genius to figure out that what goes up must come down. I do not believe the public will be fooled by any attempts to stall the necessary control measures by long drawn-out research. Certainly, our good Canadian neighbors already understand much of what must be done, and their patience is wearing thin.

Therefore, the Citizens' Task Force on Acid Rain would like to endorse H.R. 4830, while making it clearly understood that this is no substitute for action now to control the known sources of sulfur dioxide, as will be provided for in H.R. 4829.

Mr. **Scheuer**. Thank you very, very much.

My distinguished colleague?

Mrs. **Schneider**. Dr. Oppenheimer, I would like to ask you in your opinion if you feel that if the SO_2 emissions were halved, what impact would that have on acidity levels overall?

Mr. **Oppenheimer**. Being as specific as possible, I would say that if SO_2 levels were halved, my best interpretation or estimate from my own research is that we would begin to see reductions in sulfate depositions which is the main source of acidity and that my best estimate now is that a 50-percent reduction may turn into a 25- or 30-percent reduction in sulfates on a regional average and annual average basis. That is a number which is subject to change as research progresses, but, my own research has given me an understanding which has made me willing to provide an estimate.

Mrs. **Schneider**. What is your estimate based on?

Mr. **Oppenheimer**. Probably the easiest way to understand it is the following. About 20 percent of the sulfur that goes up comes down wet in rainfall. That number is well established. Now, in order for that material to come down on us in rainfall it has to be processed through a cloud at some point. When you start looking at the likelihood that a given sulfur-dioxide molecule goes through a cloud before it goes out to the ocean or gets deposited as gas on the surface of the Earth, that probability is rather small.

So when you correct for that factor you find that in fact the efficiency of transformation of sulfur dioxide into sulfates in the Northeast is very high and that the rate of transformation is such that I believe that if we cut SO_2 emissions in half it is a conservative statement to say that we would start seeing reductions in sulfates.

We might be in a lot better position than that. If we cut SO_2 in half we might see a change if not equal to, then not that far from a comparable reduction in sulfates. There is evidence of that. Emissions over the Northeast of sulfur have decreased by 20- or 30-percent average over the last decade. The continuous monitoring at Hubbard Brook has indicated a decrease of about 30 or 25 percent in the last 10 or 15 years in wet sulfur deposition.

The USGS network in New York which is not high-quality data but nevertheless is available, indicates a similar decrease in sulfates in upstate New York. We are seeing the atmosphere responding to the small decrease in SO_2 emissions which have already occurred.

Mrs. **Schneider**. Terrific. Thank you very much for that very specific answer.

I would also like to raise the whole issue of jobs if I may just for a moment.

I think that oftentimes we have a tendency to have blinder vision when we are looking at the impact of jobs when it comes to environmental pollution. I think that oftentimes this ends up being a political phony card that is raised. Because when one looks at the value of the technology that would be manufactured, for example, in dealing with acid rain, we have to consider that there would be rather a creation of jobs in the manufacture of whether it be fluidized-bed boilers or whether it be in the cleaning of coal, or whether, for example, when we are talking about auto emissions I will tell you that when we had our first vote on the Clean Air Act in the body I was approached by the manufacturers of auto emission control equipment, and they told me about the jobs that would be lost if we did not have that equipment manufactured.

So I think that this whole story works both ways and oftentimes we fail to recognize how many jobs can be created through environmental protection.

Thank you, Mr. Chairman. I have no further questions.

Mr. **Scheuer**. Let me ask both of you for any specific changes that you would recommend for either of these two bills that would make them more responsive to your concerns?

Mr. **Oppenheimer**. My simplest answer to that is that I recommend the coupling of the bill that Congressman Gregg introduced today with the bill he introduced earlier which designates a significant control strategy which is consistent with the Clean Air Coalition's position.

Mr. **Decoster**. My only comment is the elimination of Congressman Rahall's bill would be a vast improvement for a start and also the coupling of the Gregg bill with the Moffett-Gregg bill as a two-pronged approach.

To see one without linkage of some sort, some assurance that something is going to happen in the control end is a little disconcerting at home. It is a lot disconcerting. Who am I kidding? We do not want to see anybody using a research bill as a vehicle of escape for taking some real actions right now on known pollution sources.

Mr. **Scheuer**. You are right. We are sensitive to that and sympathetic with that point of view. You just heard Mr. Hill say it was the official position of the Government that the present research base did not justify any regulatory action. That is the nub of the problem right there.

Let me ask both of you a question. The Sudbury Smelter in Ontario is the single largest source of sulfur dioxide in the world.

I think it has a smokestack over 1,000 feet tall.

Mr. **Oppenheimer**. It is about 1,000 feet, I think.

Mr. **Scheuer**. So, in effect, they are presumably transporting their pollutants, too.

This utility was shut down for 6 months, and we have heard reports, that in all the measurements that were taken downwind, there was no indication of a reduction in its polluting effect, or there were no measurements that indicated there was a reduction in the levels of acidity or sulfate in the region, which perplexes us.

Does this mean that there is virtually no cause-and-effect relationship, no linear relationship between an investment in emissions pollution reduction here and actual emissions reduction there?

Mr. **Oppenheimer**. Those reports are characteristic of a lot of confusion that has been going around in this area when material that never appears in the scientific literature gets tossed about on the rumor level. The fact of the matter is that there was a publication, a detailed analysis of the Sudbury shutdown situation published earlier this year, and I can provide that reference for the record later.

And what that analysis shows is that sulfates in the downwind direction from the Sudbury plant decreased by up to 50 percent after shutdown; and that in the downwind direction there is no question that the wet deposition of pollution was significantly lower, very signficantly lower, than it would have been had the plant been operating. There is no question of that.

Mr. **Decoster**. I do not have any specific information about the Sudbury plant. I can only point to the National Academy of Sciences report that states although claims have been made that the direct evidence linking powerplant emissions to the production of acid rain is inconclusive, we find the circumstantial evidence for their role overwhelming.

I am certainly not going to contradict anything the National Academy of Sciences has to say. I am sure they have done their homework.

Mr. **Oppenheimer**. Let me just read into the record that it is a study by W. A. Scheider, et al., published in Atmospheric Environment, volume 15, which details the Sudbury situation.

Mr. **Scheuer**. I have several questions I want to ask you and I am going to submit this in writing.

We thank you very much for your fine testimony.

Mr. **Oppenheimer**. Thank you, Mr. Chairman.

Mr. **Scheuer**. Thank you for your patience.

Now, we will get to the last panel: Kurt Anderson representing the New York State Power Pool; Joseph W. Mullan, National Coal Association; and Morton Sterling, Michigan Coalition for Clean Air.

We will go in order that I called you up there, Mr. Anderson first, Mr. Mullan second, and Mr. Sterling third.

STATEMENTS OF KURT ANDERSON, NEW YORK STATE POWER POOL; JOSEPH W. MULLAN, NATIONAL COAL ASSOCIATION; AND MORTON STERLING, MICHIGAN COALITION FOR CLEAN AIR

Mr. **Anderson**. Greetings from a fellow New Yorker. I am Kurt Anderson and I am associated with the electric utilities in the State of New York. My past experience has been totally involved in the environmental area; 10 years with the New York State government and recently with the utilities.

I am here in response to a request to address H.R. 4830 and H.R. 5055. The bottom line, I think, on both of these bills, from a utility standpoint, is that the acid-precipitation phenomenon is not that well understood, and that we need a better understanding before regulatory actions are taken.

I would like to point out just a few of the reasons that I think this is an appropriate course of action.

First, we know that rainfall in its various forms is acidic. There is no question about that. However, we note great swings in the acidity and the types of acidity. In summer there seems to be a predominance of sulfuric acid. In the winter there seems to be somewhat a predominance of nitric acid.

Second, from our period of careful observations which only extends for about 5 years, we do not see that rainfall is becoming more acidic. Therefore, I guess what we need is a period of time to observe this. I think the monitoring effort that needs to go on, needs to go on for a long period of time, decades probably, to observe any major changes in direction. We cannot qualify a regulatory program as a success unless we can see some demonstrable changes in the acidity.

The scientists that you folks on this subcommittee have listened to a couple of weeks ago were the leading scientists in the acid-precipitation areas. You know what they have said. None of them profess to understand to any great degree extensive knowledge about acid precipitation. More research is needed, very clearly.

The bottom line is, I think, we cannot define the problem as far as the impacts of acidity is concerned on our ecosystems, on our crops, on our forests, or on our aquatic systems. We know that there are certain lakes, particularly in the Adirondacks, that have seen the demise of fish life within those lakes. However, they are a relatively small percentage of the Adirondack lakes. We do not know what those lakes looked like 100 years ago. We have no idea what they were like then but there are some clues that say they were somewhat different.

They may have been higher quality. They may have been similar quality. We need the research to find out.

The work that has been done to date by the Environmental Conservation Department is described in the Pfeiffer and Festa report. If you talk to those gentlemen you will find that it is a cursory report; it is nowhere near a full scientific investigation to show just what the effects are on the Adirondacks or even the extent of those effects.

We know also that when you observe nature for a period of years, that you have great swings in the quality of our environment. I identified in my testimony things such as oxygen depletion under certain icing conditions and the great changes occurring in Chesapeake Bay during the flooding of a decade ago.

We also know that fish-stocking practices in the Adirondacks are depended upon to keep a quality fishery and stocking has declined over the past two decades. About half the fish are being stocked today, mainly in the central and western Adirondacks, that were stocked two decades ago. There are budgetary problems. It is that simple I think.

Other points that we want to make are that other effects can impact the Adirondack lakes, land-use practices, the use of pesticides may have an effect. I am not saying they do. I am not saying they do not. We just do not know. We need more research in these areas.

I guess I would like to cease at this point by saying that we, the electric industry, believe that if we can take a few years, as suggested by the bills under consideration to have quality scientific work done to try to identify the impacts, try to identify the causes and understand them, then we can take appropriate action. But right now we cannot define the problem good enough to say what appropriate actions are and how effective any actions will be. It is that simple.

Thank you.

[The prepared statement of Mr. Anderson follows:]

TESTIMONY OF KURT D. ANDERSON

SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT

HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

Washington, DC
December 9, 1981

My name is Kurt Anderson and I am Environmental Affairs Manager for the New York Power Pool (an association whose members are Central Hudson Gas and Electric Corporation, Consolidated Edison Company of New York, Inc., Long Island Lighting Company, New York State Electric and Gas Corporation, Niagara Mohawk Power Corporation, Orange and Rockland Utilities, Inc., Power Authority of the State of New York and Rochester Gas and Electric Corporation) and the Empire State Electric Energy Research Corporation (ESEERCO), a nonprofit research corporation sponsored by the above seven investor-owned utilities. Prior to assuming my present position in 1974, I spent ten years as an environmental engineer in the New York State Health Department, Environmental Conservation Department and the New York State Energy Research and Development Authority. I hold a Master's Degree in Environmental Engineering and I am a Licensed Professional Engineer. In my present position, I am involved with various environmental policy and regulatory matters and I am responsible for carrying out the environmental research programs of ESEERCO, including research on acid precipitation.

H.R. 4830 addresses the need for a more complete understanding of the acid precipitation phenomenon before regulatory actions are taken. The New York electric systems, as well as the electric utility industry nationally, endorses the aims, purposes and approach taken by this proposed legislation.

As various scientists have previously testified to, the acid precipitation phenomenon is one that is extremely complex from a scientific viewpoint, in that various aspects of the phenomenon are poorly understood at best. The approach taken in this bill, that is to understand the nature of the problem before trying to effect solutions, deserves the support of Congress.

H. R. 5055 also addresses the need for research into the causes, effects and possible mitigation measures associated with the acidity in precipitation. The electric industry agrees in principle with the aims and purposes of this bill, since it also approaches the issue from the standpoint of understanding the problem, investigating possible solutions and determining the costs of the various solutions before embarking on a course of action.

I would like to just mention a few reasons why the approach taken by these bills deserves support. First, we do not deny, in fact, we very clearly understand that precipitation in its various forms is acidic. The major acidity or the ions associated with that acidity are due mainly to sulfuric and nitric acids. From our careful observations over the last approximately five years, we note that the amount of sulfuric acid in precipitation during the warmer parts of the year is roughly twice the amount of nitric acid, or a 2-1 ratio. However, during the winter, we have noted that in snowfall, there is somewhat more nitric acid present than sulfuric acid. Researchers have shown that the ratio is approximately 60-40 nitric acid to sulfuric acid during the winter.(1) A conclusion reached during the last approximately five years of careful scientific observation of the phenomenon is that rainfall is not becoming more acidic. Also, we do not have accurate enough observations prior to 1976 to tell what, if any, increased acidity is occurring compared to previous decades.(2) We will have to develop such trend information during a long-term precipitation monitoring program.

Our scientists know that the conversion of sulfur dioxide to sulfuric acid takes place at varying rates under different meteorological and climatological conditions.(3) The simplistic concept that a unit decrease in emissions will produce a corresponding decrease in acidity is fallacious. Since the conversion chemistry rates are not known with any degree of accuracy, the amount of decrease cannot, at present, be determined. This is an area where research is vitally needed.

Secondly, it has been alleged that acidity in precipitation is having harmful affects upon the nation's agriculture. As you have heard previously from noted researchers in the area such as Dr. Jacobson, it is unclear what, if any, effects the acidity in precipitation at the levels being observed has upon important agronomic species. The amount of acid ions being delivered through rainfall to crops is generally a small fraction of the acid ions being delivered to the same crops through common fertilization practices. Please note that many millions of tons of sulfur are mined each year for the purpose of fertilizer manufacture. Our farmers are spreading, in the form of sulfates, millions of tons of SO_4 on their fields each year.

Thirdly, the alleged deleterious impacts of acid precipitation upon non-agricultural plant species, such as trees, also has not been shown; in fact, we know that nitrate ions are beneficial; that is, they have a fertilizing affect on plant species. Also, we know that certain areas (especially the Northeast) which are deficient in nitrates, rely on the nitrate ions in acid precipitation to provide that nutrient. We also know that sulfate or sulfur is also needed by plants. The need varies from one region of the country to another, depending on natural sulfur levels in the soil. In portions of the southeastern United States, sulfur is somewhat deficient; while in the Northeast, the soils have sufficient levels.

Fourth, the affects of acid precipitation on aquatic ecosystems is of considerable concern, especially in the Adirondack area of New York and certain adjacent areas of New England and the Canadian provinces of Ontario and Quebec. As you have heard in previous testimony, the impact of acidity upon aquatic life, at a pH level of less than five, seems to be deleterious. This deleterious condition is exacerbated, based on research findings,(4) by the presence of aluminum ions. The synergistic effect between acidity and aluminum seems to be very important. Other chemical compounds may also play an important role but have not yet been researched.

The knowledge base of the affects of acid precipitation on aquatic systems is quite scanty. The most extensive Adirondack lake survey to date by Martin Pfeiffer and Pat Festa(5) took only a cursory look at approximately 40 percent of the 2800 Adirondack lakes. It is on the basis of this report that many suggested regulatory actions are founded.

The Adirondack area is a very complex geologic and geographic area comprising over six million acres. The diversity within that area is considerable and we find many anamolies in the alleged impacts of acid precipitation in this area. Lakes adjacent to each other in the Adirondacks exhibit markedly different chemical attributes, in that neighboring lakes will have pH differences of two units; that is, a concentration difference of 100 times when subjected to identical rainfall.(6) The physical and chemical characteristics of each watershed are different and this must be recognized because the affects of acid precipitation will manifest themselves in quite different ways from lake to lake and from watershed to watershed. Saying that the Adirondack lakes are dead simply isn't so! The Pfeiffer and Festa survey reported that more than 96.3 percent of the Adirondack lakes have a pH greater than 5.(5) Also, it has been found that some of the lakes with a pH of less than 5 have fish in them. This fact is often overlooked when the issue is discussed.

Along this same line, I would like to make the Subcommittee aware that impacts on fish populations in various lakes and streams in the Adirondacks are influenced by other factors as well. Changing land use patterns, past use of pesticides such as DDT and varying stocking practices may all contribute to varying water quality, fish abundance and long-term physical/chemical changes to the waterbody. I might point out that when stocking records of various lakes in the Adirondacks have been checked, it has been found that lakes that were previously heavily stocked have shown marked decreases in angling success when stocking of these same lakes was reduced. Man's influence on Adirondack waterbodies was noted from the turn of the century when natural reproduction in many of the Adirondack lakes could not sustain a quality fishery; artifical stocking was needed to maintain sizeable population levels of fish so that man would be able to enjoy one of his favorite pastimes. Many lakes having water quality considered marginal for natural fish reproduction were stocked to provide a put and take fishery. From New York State fish stocking records, I note that in the three central and western

Adirodack counties most heavily impacted by acid precipitation, the stocking of salmonids has decreased by a factor of two in the last two decades. It must be understood that such a decrease in stocking must impact the chance of fishing success. When you consider greater fishing pressure along with decreased stocking, the result is obviously lower catches. These points are commonly overlooked when discussing lower catches; and precipitation is cast as the only reason for the poorer fishing.

In my many years of involvement in the environmental area, I have noted that nature is constantly causing changes and that we see wide fluctuations in the populations of various aquatic species and the conditions of various waterbodies. Well documented examples of this are shallow lakes that experience an oxygen depletion under certain winter ice conditions resulting in massive fish kills. Other examples are the dramatic changes of fish populations in the upper reaches of Chesapeake Bay following the tremendous freshwater flooding associated with Hurricane Agnes a decade ago. To make any clear observations as to long-term trends in the environment, it is necessary to carefully observe it over a period of time and that is one of the aims of this bill, to take the time to make the careful scientific observations that are needed before judgments are made.

In conclusion, the electric utility industry, since it has been cast in the role of a major contributor to the acidity in precipitation, believes that additional ordered scientific inquiry is needed before regulatory actions are taken. The industry is concerned about this issue and is an active participant in acid precipitation research efforts. The proposed bills before you for consideration, H.R. 4830 and H.R. 5055, are pointed in the correct direction; that is, identifying the problem and seeking solutions based on factual evidence before a regulatory program is put into place. A few years are needed to gather the factual evidence and we ask that this time be taken before embarking on new regulatory efforts.

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(5) Pfeiffer, M.H. and Festa, P.J., "Acidity Status of Lakes in the Adirondack Region of New York in Relation to Fish Resources," Figure 6.

(6) Electric Power Research Institute, "The Integrated Lake-Watershed Acidification Study (ILWAS)," EPRI EA-1825, Project 1109-5, Interim Report, May 1981, Page vii.

Mr. SCHEUER. Thank you very much.

Mr. Mullan.

Mr. MULLAN. Mr. Chairman, I am Joseph Mullan, vice president of the National Coal Association. I, too, will try to be brief in my remarks as the total will be in the record.

Acid deposition exists and varied effects do occur. There is considerable debate over its formation and the feasibility of potential controls. The scientific community has seen the same data on acid deposition and has reached differing conclusions and thus the uncertainties. I do not wish to burden the committee with a lengthy debate on this subject, and I ask that the testimony of William Poundstone be injected into the record as well. It may well answer some of the questions.

Today, the national acid precipitation plan and its 10-year framework established under title VII of the Security Act is seeking the facts in the hope to answer these questions. The coal industry does not wish, however, to use unanswered questions as an excuse for delay. We therefore strongly enforce H.R. 5055 which calls for an accelerated effort to understand the causes and effects of acid precipitation.

We favor intensification of research efforts aimed at producing results within 5 years. However, in order that meaningful results are produced in the accelerated timeframe, it will be necessary to concentrate on carefully defined objectives.

We believe that to insure meaningful and effective results that accelerated research in acid deposition should be concentrated in the following areas. One, extension and refinement of the current base; two, transport transformation, and deposition processes, and three, mitigation and coal cleaning. I have gone into detail in the testimony on each of these subjects and I would not take the time to repeat, but will state that concerning the refinement of current data base, we believe the varying sampling methods, diverse analytical techniques along with lack of quality control have resulted in, at best, questionable data base.

The National Coal Association has established its own airsampling network from the Rockies to the east coast and up into Canada in an attempt to improve upon the data of the national deposition network.

Again, on transport and transformation just as many questions remain. We have scientists on one side who say acid deposition is a long-range transport problem. Other scientists have stated that it is a short-term circumstance, the major cause of which is local sources.

Some of this could be observed if one goes downstream from that smelter that you referred to in your testimony. Certainly downstream from a source of that size it is easy to define the problem under mitigation efforts, and this is one in which we think much has been left out.

Evidence of harm from acid rain involves a possible acceleration of aquatic acidification in naturally sensitive lakes with an inherent inability to buffer incoming acidity. The replacement of natural alkaline agents could, in theory, resolve the problem and has done so in the past.

Analysis of lake restoration projects have already been undertaken. The addition of limestone has been confirmed as a potentially effective mechanism for combating lake acidification. Such introduction has increased pH, increased plankton, better balances in total fish biomass, and has shown decreases of potentially toxic heavy metals.

Liming may not be feasible everywhere. Other efforts are being undertaken now in Sweden such as injection of hydrogen and oxygen. We would be happy to supply that information to you. We are simply saying that instead of sitting back and waiting for the results of 5 years of study, we can be doing things with the lakes right now.

We know something about acid water in the coal industry. We have to treat acid water every day, and we would be willing to sit down with you to discuss our savior efforts in water reclamation.

Mr. **Scheuer**. Excuse me. On that point, could you make some recommendations to us for legislation that would establish some type of regulatory standards for water that would involve the processes you are discussing?

Mr. **Mullan**. In our particular states there are pH standards for water in the coal-mining States. We would certainly be glad to sit down and discuss it with you.

Mr. **Scheuer**. We would be happy to do that.

Mr. **Mullan**. I cannot find something that is quite the same color, but we have had to take red water about the color of that napkin in front of us, and that water has to be fishable and swimmable. So when one tells me that we have a severe problem in a particular lake, I think one is forgetting that you might be able to treat the lake. The Swedes have learned a lot in that area. We have learned a lot.

Mr. **Scheuer**. How do you treat the lake besides liming?

Mr. **Mullan**. In the case of Sweden, they are injecting hydrogen and oxygen into the lake itself. There are a whole series of things. You look at the watershed itself, what is causing the problem with the lake. It is the base of the lake.

I am taking more time than I should, but we certainly could discuss this at length with you at another time. I share your problem. I have a plane to catch.

As I say, I would like to add just one last comment. I had not intended to discuss the Harris Poll today and I am not sure that you had as well, but since it was brought up I simply wish to supply for the record a poll that was released yesterday by Opinion Research which has somewhat totally different results than the Harris Poll and I will just take one point out of it.

Mr. **Scheuer**. Could you give us the entire poll for the record?

Mr. **Mullan**. I will. That is no problem at all, sir.

I will take one sentence from the document. I did not bring it with me. The survey showed that 81 percent of the public and 78 percent of environmental activists agree that changes in the act probably can be made so that air quality can be protected at a lower cost than now. I think lower cost is very important, particularly in your part of the country. I live in New Jersey and we have some of the same problems, the costs for people on fixed incomes.

Mr. **Scheuer**. I certainly hope they are right.

Mr. Mullan. I will supply you with the complete background on that.

Mr. Scheuer. I would appreciate that very much.

[The information follows:]

TABLES

Between September 19th and 24th, the Harris Survey asked a cross section of 1,249 adults nationwide by telephone:

"Congress will soon reconsider the Clean Air Act, which is now ten years old. Given the costs involved in cleaning up the environment, do you think Congress should make the Clean Air Act stricter than it is now, keep it about the same, or make it less strict?"

STRICTNESS OF CLEAN AIR ACT

	Make it stricter	Keep about the same	Make it less strict	Not sure
	%	%	%	%
Sept. 1981	29	51	17	3
May	38	48	12	2
February	36	46	12	6
September demographics				
East	35	45	18	2
Midwest	25	55	16	4
South	25	54	17	4
West	33	47	17	3
Cities	34	49	14	3
Suburbs	32	48	19	1
Towns	31	49	16	4
Rural	21	56	19	4
Age 18-29	40	50	10	-
30-49	26	52	19	3
50-64	25	48	22	5
65 & over	21	52	19	8
8th grade	20	48	20	12
High school	30	50	17	3
College	30	51	17	2
Men	24	53	22	1
Women	34	48	13	5
White	27	53	17	3
Black	36	40	17	7

continued

STRICTNESS OF CLEAN AIR ACT (CONT'D)

	Make it stricter	Keep about the same	Make it less strict	Not sure
	%	%	%	%
$7,500 or less	35	45	17	3
$7,501-15,000	31	50	16	3
$15,001-25,000	33	52	13	2
$25,001-35,000	22	53	24	1
$35,001 & over	21	56	21	2
Professional	28	55	15	2
Executive	36	44	20	-
Proprietor	35	46	18	1
Skilled labor	25	54	21	-
White collar	30	52	16	2
White Protestant	24	54	19	3
White Catholic	32	51	15	2
Jewish	29	67	4	-
Union member	32	50	16	2
Voted Reagan '80	24	52	22	2
Voted Carter '80	29	50	17	4
Republican	23	52	22	3
Democrat	33	51	13	3
Independent	28	49	21	2
Conservative	25	51	21	3
Middle of road	29	54	16	1
Liberal	37	45	15	3

"Now I'm going to ask you about some specfic changes that are being considered in the Clean Air Act. For each, tell me whether you favor or oppose the change."

CHANGES IN CLEAN AIR ACT

	Favor	Oppose	Not sure
	%	%	%
Postpone the current deadlines for auto companies meeting auto pollution standards	42	54	4
Relax current auto pollution standards	38	58	4
Postpone current deadlines for electric companies meeting power plant pollution standards	37	57	6

CHANGES IN CLEAN AIR ACT (CONT'D)

	Favor %	Oppose %	Not sure %
Relax regulations that protect national park and wilderness areas from air pollution	36	61	3
Relax national air quality standards	34	61	5
Relax pollution standards to allow power plants to burn higher sulphur content oil and coal	29	66	5

"The Clean Air Act does not permit the consideration of costs when setting standards for the protection of human health. The Reagan Administration is considering asking Congress to require that pollution standards designed to protect human health be relaxed if the costs are too high. Do you favor or oppose relaxing pollution standards affecting human health if the costs are too high?"

RELAX POLLUTION STANDARDS PROTECTING HUMAN HEALTH IF COSTS TOO HIGH?

	Favor relaxing standards %	Oppose relaxing standards %	Not sure %
TOTAL NATIONWIDE	32	65	3
East	33	66	1
Midwest	35	61	4
South	33	63	4
West	26	72	2

continued

RELAX POLLUTION STANDARDS PROTECTING HUMAN HEALTH IF COSTS TOO HIGH? (CONT'D)

	Favor relaxing standards	Oppose relaxing standards	Not sure
	%	%	%
Cities	29	68	3
Suburbs	31	66	3
Towns	33	65	2
Rural	37	58	5
Age 18-29	27	72	1
30-49	35	62	3
50-64	36	62	3
65 & over	34	59	7
8th grade education	30	64	6
High school	31	65	4
College	34	64	2
Men	39	58	3
Women	26	70	4
White	33	64	3
Black	31	67	2
$7,500 or less	28	69	3
$7,501-15,000	30	68	2
$15,001-25,000	28	70	2
$25,001-35,000	37	61	2
$35,001 & over	41	55	4
Professional	32	64	4
Executive	43	55	2
Proprietor	43	52	5
Skilled labor	30	69	1
White collar	31	69	-
White Protestant	37	59	4
White Catholic	26	72	2
Jewish	23	75	2
Union member	31	67	2
Voted Reagan in '80	41	56	3
Voted Carter in '80	25	72	3

continued

RELAX POLLUTION STANDARDS PROTECTING HUMAN HEALTH IF COSTS TOO HIGH? (CONT'D)

	Favor relaxing standards	Oppose relaxing standards	Not sure
	%	%	%
Republican	42	56	2
Democrat	26	71	3
Independent	33	65	2
Conservative	41	56	3
Middle of the road	31	67	2
Liberal	22	76	2

- = no response

METHODOLOGY

This Harris Survey was conducted by telephone with a representative cross section of adults 18 and over at 1,249 different sampling points within the United States between September 19th and 24th. Figures for age, sex and race were weighted where necessary to bring them into line with their actual proportions in the population.

In a sample of this size, one can say with 95% certainty that the results are within plus or minus three percentage points of what they would be if the entire adult population had been polled.

This statement conforms to the principles of disclosure of the National Council on Public Polls.

PUBLIC ATTITUDES TOWARD THE CLEAN AIR ACT

(A Report Prepared for the Chamber of Commerce of the United States)

I. ABOUT THE SURVEY

This report presents the findings of a survey conducted by Opinion Research Corporation for the Chamber of Commerce of the United States to evaluate public attitudes toward the Clean Air Act.

The results are based on telephone interviews among a probability sample of 1,004 noninstitutionalized adult residents of the United States. For the purposes of this survey, adults were defined as aged 18 and over.

The questionnaire was pretested November 18, 1981, to make sure that the questions were understandable. The actual interviewing was conducted from November 20 to November 22, 1981.

Sampling Procedures -- Household Selection

The essential characteristic of probability sampling is that, for each person in the population under study, the probability that he will be included in the sample can be specified. This means that the degree of reliability of any finding from a study based on probability sampling can be estimated mathematically.

The sampling plan used to generate a probability sample of telephone-owning households for each part of this survey was Two-Stage Random Digit Dialing. This design gives all household telephones, both listed and unlisted, an equal probability of selection.

The first step in this sampling procedure was to obtain the list of all working combinations of area codes and three-digit prefixes in the continental United States. The tape containing these is available from AT&T. From these six-digit numbers we randomly generated, with replacement, complete telephone numbers by adding four-digit random numbers to the area code-prefix combinations.

The initial telephone number used to define a primary sampling unit (PSU) was called; and if the number was a residential number, the entire bank of numbers from which it came was retained. If the number was a nonworking or business listing, then the PSU was discarded. Therefore, we selected PSU's with probability proportional to the number of residential phones.

Since the banks of numbers were distributed in proportion to the number of households in each census region, the Two-Stage Random Digit Dialing procedure gave us a probability sample of residential telephone households in the continental United States.

Sampling Procedure -- Respondent Selection

Within sample households, probability procedures were used to predesignate the specific person to be interviewed. All members of the household 18 years of age and over were first listed in a prescribed manner on a form provided for this purpose. Random numbers, in a mathematical sense, were used to designate one specific person in the sample household to be interviewed. The interviewer was not permitted to make any substitutions.

To control nonresponse, interviewers made up to two callbacks (for a total of three calls) to each household where the designated respondent was not at home at the time of the interviewer's first call.

At the data processing stage, the sample was balanced against census data to ensure that it represented the population of noninstitutionalized adults in the continental United States.

Interviewing Procedures

All interviewers who worked on this survey were carefully briefed on the specifics of the study — both the question wording and the sampling procedures — and were under the constant supervision of trained interviewer supervisors (who were also briefed). The performance of each interviewer was monitored during the course of the study.

Data Preparation and Tabulations

All completed questionnaires were coded and edited. Then the data were keypunched, verified, and checked for internal consistency, and the sample was balanced against census data. The output of this process is a series of computer tables listing the percentage results for each survey question (Appendix 1). A title for each question is shown along with the table containing results for that question.

Computer tabulations read across. All figures in the body of the computer tables are percentages, with the exception of the first vertical columns (the unweighted and weighted number of cases within the specified subgroup), and the top horizontal line (representing the total number of responses within each specified answer category). Where percentages add to more than 100 or the total shown, it is because of machine rounding or multiple answers on the part of respondents.

Notes on Reading This Report

The next section of this report includes our summary of the findings. This is followed by the detailed findings, with marginal references to the specific questions. The detailed computer tabulations appear in Appendix 1, and the survey questionnaire appears in Appendix 2.

Unless otherwise specified, all figures shown in this report are percentages. Percentages read across where percent signs are shown in the left-hand column of a table; percentages read down where percent signs appear at the top of the columns. When percentages add to more than 100, it is due to multiple answers on the part of respondents.

Reliability of Survey Percentages

It is important to bear in mind that the results of any sample are subject to sampling variation. The magnitude of the variation is measurable and is affected by the number of interviews and the level of the percentages expressing the results. Tolerances are also involved in the comparison of results from different parts of any one sample. A difference, in other words, must be of at least a certain size to be considered statistically significant.

The table below shows the possible sample variation that applies to percentage results for this survey. The chances are 95 in 100 that a survey result does not vary, plus or minus, by more than the indicated number of percentage points from the result that would be obtained if interviews had been conducted with all persons in the universe represented by the sample. The first sample size figure shown corresponds to the total sample of 1,004 respondents.

Approximate Sampling Tolerances (at 95% Confidence) To Use in Evaluating Percentage Results Appearing in This Report

Number of People Asked Question on Which Survey Result Is Based	Survey Percentage Result at or Near This Level:				
	10% or 90%	20% or 80%	30% or 70%	40% or 60%	50%
1,004	2%	2%	3%	3%	3%
1,000	2%	2%	3%	3%	3%
900	2%	3%	3%	3%	3%
800	2%	3%	3%	3%	3%
700	2%	3%	3%	4%	4%
600	2%	3%	4%	4%	4%
500	3%	4%	4%	4%	4%
400	3%	4%	4%	5%	5%
300	3%	5%	5%	6%	6%
200	4%	6%	6%	7%	7%
100	6%	8%	9%	10%	10%
50	8%	11%	13%	14%	14%

Sampling tolerances are also involved in the comparison of results from different parts of a sample (subgroup analysis). The table below shows the percentage difference that must be obtained before a difference can be considered statistically significant. These figures, too, represent the 95% confidence level.

Approximate Sampling Tolerances (at 95% Confidence) To Use in Evaluating Differences Between Two Percentage Results Appearing in This Report

Comparison of Numbers of People Asked Question on Which Survey Results Are Based	Survey Percentage Results at or Near This Level:				
	10% or 90%	20% or 80%	30% or 70%	40% or 60%	50%
1,000 vs. 1,000	3%	4%	4%	4%	4%
800	3%	4%	4%	5%	5%
600	3%	4%	5%	5%	5%
400	3%	5%	5%	6%	6%
200	5%	6%	7%	7%	8%
100	6%	8%	9%	10%	10%
50	9%	11%	13%	14%	14%
800 vs. 800	3%	4%	4%	5%	5%
600	3%	4%	5%	5%	5%
400	4%	5%	6%	6%	6%
200	5%	6%	7%	8%	8%
100	6%	8%	10%	10%	10%
50	9%	11%	13%	14%	14%
600 vs. 600	3%	5%	5%	6%	6%
400	4%	5%	6%	6%	6%
200	5%	6%	7%	8%	8%
100	6%	8%	10%	10%	11%
50	9%	12%	13%	14%	14%
400 vs. 400	4%	6%	6%	7%	7%
200	5%	7%	8%	8%	8%
100	7%	9%	10%	11%	11%
50	9%	12%	13%	14%	15%
200 vs. 200	6%	8%	9%	10%	10%
100	7%	10%	11%	12%	12%
50	9%	12%	14%	15%	15%
100 vs. 100	8%	11%	13%	14%	14%
50	10%	14%	16%	17%	17%
50 vs. 50	12%	16%	18%	19%	20%

Distribution of the Sample

The table below shows the number of respondents in each subgroup of the total sample. (Where subgroups do not add to the total of 1,004 it is because respondents failed to answer the relevant survey question.)

	Number of Respondents
Total public	1,004
East	224
Midwest	264
South	320
West	196
Men	503
Women	501
High school incomplete	185
High school complete	338
Some college or college graduate	474
18-29 years of age	281
30-39	256
40-49	133
50-59	152
60 years or older	179
1980 household income under $10,000	158
$10,000 - $14,999	157
$15,000 - $24,999	277
$25,000 - $34,999	183
$35,000 or over	154
White	863
Nonwhite	129
Democrat	392
Republican	324
Independent	162
Liberal	319
Conservative	568
Somewhere in between	67
Environmental activist	104
Sympathetic	578
Neutral	210
Unsympathetic	72
Aware of Clean Air Act	730
Not aware of Clean Air Act	274

Staff Responsibility

The Chamber of Commerce study was under the overall supervision of Harry W. O'Neill, President of Opinion Research Corporation. Also working on the study were Debra A. Keeney, Research Associate, and Kenneth Schwartz, Vice President.

As required by the Code of Standards of the Council of American Survey Research Organizations, we will maintain the anonymity of our respondents. No information will be released that in any way might reveal the identity of a respondent. This report may be reproduced and released as a whole, but our authorization is required for any external publication of only part of the research findings or their implications.

II. SUMMARY OF FINDINGS

Overview

There is no question about the American public's desire for clean air and for continued efforts to improve the country's air quality. This has been demonstrated in survey after survey. With Congress about to review the Clean Air Act, there can be the temptation to interpret such survey findings as evidence of public opposition to any change in the Act. This is an erroneous conclusion, as the survey reported here demonstrates.

The current survey goes beyond the more narrow confines of attitudes toward air quality and standards and asks specifically about changes in the Clean Air Act. The result: Most people are uninformed about the goals of the Act and about how the public and business are to achieve these goals. The public can distinguish between changes that are administrative and procedural and those that would affect air quality standards. There is sizeable support for reviewing the Act in the light of past experience and current technology. There is sizeable support for administrative changes that do not affect standards. There is sizeable agreement that changes in the Act probably can be made so that the cost of compliance can be reduced without lowering air quality. There is sizeable support for the proposition that air pollution controls should vary from area to area, depending on the local situation, rather than requiring in all areas the stricter controls that are necessary in a few areas to combat particularly bad air.

Opinions About Air Quality

The public is not particularly pleased with the nation's air quality. Only three people in ten rate the air quality in the country as a whole as excellent or good and only 16% say the situation has improved over the past five years. When appraising their local area, people's opinion is somewhat better -- just over half say the air quality is excellent or good. Even so, only 12% say the air quality in their area is better than it was five years ago.

A significant minority -- three people in ten -- say there should be no air pollution of any kind and another four in ten say not only should there be no air pollution that would endanger health, but also none that interferes with recreation and natural resources. Only 23% of the public opts for the more limited goal of judging air quality just in terms of health. Also, only 22% support the proposition that environmental standards must be relaxed in order to achieve business and new job growth, while 93% agree that all new or modified industrial plants should be required to use the best available control technology for achieving clean air.

What about the costs for clean air? When people are told that the EPA estimates the cost for air pollution control from 1970-1987 will be $400 billion, only 28% say costs for having clean air should be at a lower level. About the same proportion say even more should be spent and another third opt for costs to be continued at the current level.

Further, the public supports the role of the government in pollution control -- 71% favor the federal government setting and enforcing national air quality standards. Only 18% are opposed.

The Clean Air Act -- Review and/or Change?

With the Clean Air Act up for Congressional review, it is all too easy, in light of the above findings, to conclude that the public would be opposed to any suggestions for change and fearful that change would mean reduced air quality. Such is not the case, however. The public, including those who claim to be active participants in the environmental movement (11% of the public), seems willing and able to distinguish between changes that are administrative and procedural in nature and those that would lower standards. Consider the following:

- 93% of the public and 96% of environmental activists agree that it is a good idea to review the Clean Air Act because experience with it may indicate needed change.
- 86% of the public and 85% of environmental activists favor the federal government's periodically reviewing its clean air standards and its enforcement policies and procedures to make sure they are up-to-date.
- 72% of the public and 74% of environmental activists favor administrative changes in the Clean Air Act that do not affect air quality standards.
- 81% of the public and 78% of environmental activists agree that changes in the Act probably can be made so that air quality will be protected at a lower cost than now.
- 69% of the public and 59% of environmental activists disagree that any change in the Act will most likely result in air that is dirtier than now.
- 51% of the public and 40% of environmental activists believe that states, once their clean air plans have federal government approval, should have the right to make procedural changes and streamline their paperwork without further federal government approval if the changes do not affect air quality.

Knowledge of the Clean Air Act

Discussions of public reaction to the current Congressional review of the Clean Air Act also must be viewed in light of awareness of and knowledge about the Act. And both are fairly low.

While two-thirds of the public claim at least "a little" awareness of the Act, only 8% say they have heard or read "a great deal" and another 21% "a fair amount." Among the public at large, 31% claim no awareness of the Act and among environmental activists the figure is 28%.

When those who claim at least "a little" awareness are asked what they know of the goals of the Act, 43% of the general public and 49% of environmental activists are unable to provide an answer. They say they do not know. Therefore, fewer than a third of the public have any understanding of the Clean Air Act. And, even among those who are willing to discuss the goals of the Act, their answers are very general in nature -- e.g., reduce air pollution. Thus, any unqualified statistics that say the public opposes changes in the Clean Air Act should be viewed with caution.

Actions With Respect to Clean Air Standards

In their local area, people regard clean air as important, but not overriding to economic interests. Opinion on the relaxation of local clean air standards to prevent unemployment and help the economic situation is divided -- 47% in favor, 47% in opposition. However, 60% oppose closing local factories until they make the necessary changes to meet clean air standards, if such closing would result in unemployment and economic damage to the area. (Here, environmental activists depart from the rest of the public. The majority (57%) favor such factory closings.) And 90% favor allowing factories to be built if there is a good chance that they will meet the clean air standards.

Also, 85% of the public -- and a similar proportion of environmental activists -- favor continued industrial construction in areas that have not yet met their national clean air goals if the local areas continue to make progress toward meeting these goals and the new industrial facilities agree to use the best pollution controls available.

As to cutting off federal funds for such things as sewers, roads, and parks to cities and counties that have not met their clean air goals, opinion is reasonably divided -- 48% oppose such an action and 42% favor it. (Among environmental activists the figures are 42% in opposition and 54% in favor.)

Opinion is much more decisive with respect to varying air pollution controls depending on the area. Seventy-eight percent of the public and 70% of environmental activists believe that controls should vary from area to area depending on the local situation rather than requiring the stricter controls that are needed in a few areas to combat particularly bad air.

Credibility of Sources When Recommending Changes in the Clean Air Act

With the Clean Air Act up for review, recommendations for change may come from many sources -- and their credibility varies considerably among both the general public and environmental activists (although both are in agreement in their ranking of the various sources).

Most credible, cited by at least two-thirds of both the public and environmental activists, are the federal EPA, environmental groups, university professors, and state government officials. At the bottom of the list -- and the only group cited by a majority as one not to be trusted -- is business and industry. Also drawing a significant amount of distrust are the news media and the Congress.

Mr. **Scheuer**. Let me ask you a couple of questions.

Mr. Anderson, you mentioned that the National Coal Association has instituted a comprehensive monitoring network?

Mr. **Anderson**. I think Mr. Mullan did.

Mr. **Scheuer**. Oh, was it Mr. Mullan?

Mr. **Mullan**. Yes, sir.

Mr. **Scheuer**. Why did you start your own network?

Mr. **Mullan**. Very simple, sir, we started looking at the questions relative to the existing networks. We found that some of the networks had one type of sampler at one place and a different kind at another. One was monitoring on a monthly basis, one on a weekly basis, and another one on the incident basis. None of the people were trained the same way.

We decided the only way to get good data across the country was to use one sampling device and train all the operators in our own research laboratories and to try to get rid of some of the questions in the data base. I find that others are doing the same thing today. I think there is an improvement in everybody's data base.

[The prepared statement of Mr. Mullan follows:]

STATEMENT OF JOSEPH W. MULLAN, VICE PRESIDENT, NATIONAL COAL ASSOCIATION

Good afternoon, Mr. Chairman and members of the subcommittee.
I am Joseph W. Mullan, Vice President of National Coal Association, an association of coal producers, sales companies and organizations with an interest in the coal industry. We appreciate this opportunity to discuss research and development programs aimed at a fuller understanding of the phenomenon of acid precipitation.

INTRODUCTION

In the past several years, and particularly since enactment of the 1977 Clean Air Act amendments, there has been increased attention on the causes and potential effects on terrestial and water systems of acid deposition or more popularly referred to as "Acid Rain." Acid deposition exists, and varying effects do occur, but there is considerable debate over the circumstances of its formation and the feasibility of potential controls. The scientific community has seen the same data on acid deposition and invariably has reached differing conclusions and thus uncertainties. I will not belabor this subcommittee with an extensive review of what the coal industry believes to be the known facts in this matter. Rather, I would request that testimony prepared and presented by William N. Poundstone, Executive Vice President of Consolidation Coal Company to the subcommittee on Health and Environment of the House Committee on Economy and Commerce be made part of the official record of this hearing. Mr. Poundstone is a noted authority on the acid deposition issue and speaks to the fundamental technological and scientific questions of the debate.

To resolve the controversies involved in the acid precipitation question, the critical, unresolved issues surrounding the phenomenon must be carefully considered. The American people have the right to expect that their Government will not impose an additional multi-billion Dollar program without first determining with some certainty commensurate social and environmental benefit. Congress recognized the importance of careful evaluation of the phenomenon when it enacted a comprehensive program aimed at understanding the causes and effects of acid deposition in the Energy Security Act of 1980.

There are those, however, that have characterized the National Acid Precipitation Assessment Plan and its ten year frame established under

Title VII of the Energy Security Act as protracted relay. The coal industry does not wish to use unanswered questions as an excuse for delay. We, therefore, strongly endorse H.R. 5055 which calls for an accelerated effort to understand the causes and effects of acid precipitation. We favor intensification of research efforts aimed at producing defensible results within 5 years. However, in order that meaningful results are produced in this accelerated time frame, it will be necessary to concentrate on carefully defined objectives. This will require a well planned, coordinated effort by Government and industry. As noted by the recent General Accounting Office report, the acid rain debate is "unnecessarily confused by inaccurate and misleading statements." It is our hope that a well defined research effort will alleviate these concerns.

Research Needs

To help insure meaningful and effective results, NCA believes that accelerated research in the acid deposition debate be concentrated in the following areas:

1. Extension and refinement of the current data base
2. Transport, transformation and deposition processes
3. Mitigation and coal cleaning

Specifics

1. Extension and refinement of the current data base

   Much of the confusion and controversy surrounding the entire acid deposition issue eminates from diverse and conflicting data. Varying sampling methods, frequencies, analytical techniques, along with a lack of quality control, have resulted in an, at best, questionable data base. In an effort to obtain reliable monitoring data and evaluate the conflicting claims regarding acidity trends, the National Coal Association has instituted a comprehensive monitoring network that extends from the Rockies to New England and Canada. The program is designed to avoid many of the problems of the past. The end result should be an improved and expanded data base for determining actual acid precipitation as a function of time and place. It is the hope of NCA that any accelerated research on the part of the

USEPA and the interagency task force will include an expanded, well defined and maintained network of monitoring stations incorporating the previously mentioned objectives. Without a reliable data base as a basic foundation, other reserach will no doubt yield questionable results.

2. Transport, transformation, and deposition processes

The question of the precise causes of the acid rain phenomenon remains unanswered. At present, no one has been able to determine the extend to which airborne emissions are contributing to the acidification of deposition, whether wet or dry. Likewise, no one can determine what effect anthropogenic emission reductions would have on current levels of acidity. Without the answer to these questions, or at the very least a far better understanding than we currently have, we cannot with sufficient confidence develop programs to reduce or control acid deposition. What is clear, however, is that the chemistry involved in the formation of acid rain is complex and is not understood. For example, uncertainty regarding chemical transformation prevents scientists from establishing exactly how sulfates and nitrates are derived, their origin and how they could be controlled.

Long range transportation is also the subject of considerable controversy. Acid precipitation in the northeast has routinely been attributed to emissions from industrial sources located in the midwest. The basic argument underlying this assumption, i.e. that significant percentages of emissions are typically transported over long distances, has not been verified with any decree of scientific scrutiny. Two separate studies have recently augmented our position. The first, a Department of Energy study entitled "Acid Rain: The Impact of Local Sources" suggests that the long range transport of emissions from coal fired power plants may not play as significant a role in determining downwind sulfate levels as has been alleged. Likewise, the Federal Interagency Task Force on Acid Precipitation in the National Acid Precipitation Assessment Plan concluded that it is"not possible to determine with confidence the extent to which any specific source or collection of sources in one region lends to acid deposition in another region."

The final unknown in the acid deposition sequence is cloud chemistry. The role of cloud chemistry is quite significant, since the incorporation of atmospheric pollutants in precipitation may be influenced by a variety of factors unrelated to ambient levels of apparent precursors. Until this phenomenon is more clearly understood, claims involving the formation of acid deposition can not be satisfactorily evaluated.

NCA, therefore, urges that the transformation transport and ultimate deposition of airborne pollutants be quantified through scientifically defensible approaches. Intense atmospheric process research is a must if we are to obtain a better understanding of the actual mechanism of the phenomenon.

3. Mitigation Efforts

Given the vast uncertainty that at this time surrounds the causes and effects of acid deposition, there is little or no agreement on how much precipitation quality would change even if substantial emission reductions were imposed. Without, at the very least, preliminary results from the aforementioned research projects, no one knows what effect any emission reductions, particularly at distant sources, would have on precipitation quality.

Since the casual relationship between emissions and ecological impacts associated with acid deposition is so uncertain, NCA believes it would be far more effective if specific ecological concerns were identified and measures were instituted to remedy the problems directly. As reported by GAO, the only clear evidence of harm from acid rain involves the possible acceleration of aquatic acidification in naturally sensitive lakes. Since lakes typically acidify as a result of an inability to buffer incoming acidity, the replacement of natural alkaline agents could in theory address this problem (and has done so in the past). Analyses of lake restoration projects that have already been undertaken confirm that the addition of limestone may constitute a potentially effective mechanism for combatting lake acidification. Researchers report that the introduction of lime has led to: (1) increases in pH, (2) increases in the diversity of phytoplankton and zooplankton species, (3) better balances in total fish biomass and (4) decreases in concentrations of potentially toxic heavy metals. While liming is not feasible everywhere, it may be an important interim measure to mitigate the effects of acidification until there is more certain knowledge of its causes. This an other mitigation measures should be pursued vigorously while the necessary research to determine causes of environmental acidification is underway.

4. Coal Cleaning

Due to the substantial lelvel of coal washing already being pursued, the emissions reductions from a broad coal washing program may be relatively small. However, when used on selective coals, coal washing is a relatively cost-effective means of pre-combustion emissions reduction. Given this fact, NCA would urge that further research be conducted on all areas of coal cleaning. For example, NCA has actively participated in two projects involving coal cleaning with EPA. The first addressed the critical sulfur variability of raw or run of mine coal versus the same coals that have been processed. The second project analyzed the environmental impact of increased coal cleaning outlining air, water, soil and biological conditions. Both studies were well conceived and expertly conducted. Due to budgetary constraints, however, these critical projects were terminated prior to final completion. NCA urges that such projects as these become an integral part of any accelerated research on acid deposition.

Conclusion

Acid deposition is a reality - one of major concern. The depth of our concern about acid deposition should be reflected in public policies that are based upon sound science. In passing the Acid Precipitation Act of 1980, Congress itself established a comprehensive intergovernmental and interdepartmental research plan so that the complexity of acid deposition could be fully understood. To the extent that H.R. 5055 and H.R. 4830 call for an acceleration of this research effort, NCA wholeheartedly concurs. We caution against and would strongly object to, however, any attempt to impose additional emissions regulations prior to completion of the necessary research. The expenses associated with significant emissions reductions will be very great.

This concludes my prepared statement. I would be happy to respond to any questions you may have.

Mr. SCHEUER. Before we hear from Mr. Sterling, let me just ask you what your monitoring has shown today, what are the specific conclusions?

Mr. MULLAN. There is acidity in the atmosphere, sir.

Mr. SCHEUER. You did not have to start a new monitoring system to come up with that?

Mr. MULLAN. No; I think we have the same concerns that have been expressed by others. The monitoring network begins in the Rockies and it goes to the east coast in our case. We are trying to find out whether there is, in fact, a long-range transport to the extent to which long-range transport plays a role. We are looking at concentrations in specific areas to see if we can identify what are the sources.

Mr. SCHEUER. I tell you what. Why don't I ask you to submit for the record why you set it up and also to the degree to which your network is coordinated with other Federal and non-Federal networks in terms of quality control.

Mr. MULLAN. Certainly.

[The information follows:]

Question 1a

Why did NCA start its own network?

One of the most publicized, yet least understood, subjects is the phenomenen of acid rain. Despite the many studies and the inordinate amount of rhetoric that has been generated by them, most aspects of the acid rain issue remain subject to considerable debate. In an effort to develop scientific knowledge to answer the many remaining questions, a massive research effort has been initiated by Government and industry. The coal industry joined in this effort in November 1979, when the National Coal Association's Board of Directors authorized the establishement of a precipitation network. This network, known as the NCA/BCR Precipitation Quality Network (PQN), commenced activity in May 1980, when the sampling station at Bituminous Coal Research, Inc. in Monroeville, Pennsylvania, became operational. A Work Plan was developed to ensure that all companies operating stations in the network are thoroughly familiar with all facets of the network operation. The plan stresses the importance of the network uniformity and details the responsibilities of the participants, and of BCR as coordinator of the program. Criteria for site selection, instructions regarding station operation, sampling schedule, analytical procedures, and data reporting are included in the plan, which was distributed to all participants. The Work Plan manual is revised or up-dated as necessary.

The overall goal of the network is to establish an independent data base that will:

1. Provide first-hand information concerning precipitation quality in those geographic areas and regions covered by PQN monitoring stations;
2. Be available for use and interpretation by the NCA Environmental committee and the participating members of the network;
3. Be used to verify the data obtained by other precipitation networks; and
4. Provide a basis for evaluation of many of the conclusions reached by other researchers.

Question 1b

Is your network coordinated with other federal and non-federal networks in terms of quality control?

The NCA/BCR Precipitation Quality Network (PQN) consists of two major components, each with "built-in" quality assurance. They are:

a. Observer Training

Prior to initiating of the network, three training sessions were conducted for the monitoring stations observers. These sessions were attended by 73 observers and other personnel from 43 stations. Personnel from the remaining 9 stations are being trained by Bituminous Coal Research, Inc. on an individual basis. The course was designed to stress the importance of the field observers in the success of the program, and to familiarize them with the procedures to be used in operating each station, collecting data, and collecting, analyzing and shipping precipitation samples. Each observer was given the opportunity to carry out the complete procedure, using the sampling and analytical equipment that is to be used in the field. The procedures are contained in the Field Observer Instruction Manual which was prepared by BCR and distributed to all sampling station personnel. Strict adherence to this protocol is necessary to ensure that the highest quality data will be developed.

b. Sample Analyses

During the developmental stages of the PQN, the decision was made that a central laboratory would not be utilized. Instead, each participating company volunteered to arrange for the analyses of the samples from their monitoring stations. By using multiple labs, sample analyses can be initiated on the day the sample is collected. This is especially important during those periods when sampling will be done on an event basis. The disadvantage is that analytical errors are compounded due to the variety, quality and condition of the instrumentation being used, and the large number of analysts involved. BCR is developing a quality assurance program to minimize these errors to the degree possible. Prior to initiation of the PQN, several sessions were held with representatives of other precipitation monitoring networks, most notably:

a. National Atmospheric Deposition Program (NADP)
b. Electric Power Research Institute (EPRI) Precipitation Chemistry Network
c. Tennessee Valley Authority (TVA) Network

At these meetings, the protocols and procedures for sampling, analyses, quality assurance, etc. were reviewed and approved.

Question 1c

What has your monitoring shown to date?

Given that the complete PQN has been operational for less than one year, it is difficult to determine any trends, variations, similarities, anomalies, etc. Quite frankly, the first months of sample gathering and analysis were spent "working the bugs" out of the system and making adjustments to various procedures. As NCA has indicated early on in the project, it is not expected that significant results will be documented during the first two years of the project. The coal industry is committed to continue this effort until sound, defensible data is forthcoming.

Mr. SCHEUER. Now, let's hear from Mr. Sterling.

Mr. STERLING. Thank you very much, Mr. Chairman. The Michigan Coalition for Clean Air appreciates the opportunity to testify today.

My name is Morton Sterling and I am testifying on behalf of the coalition regarding H.R.4830.

For your information, the coalition is composed of approximately 47 large industrial and manufacturing companies, associations, and labor groups. It was organized early this year to consider recommended changes in the Clean Air Act. The coalition is seriously concerned about any proposed acid-precipitation legislation which would impose additional sulfur dioxide emission restraints in Michigan, since the industry has already taken major curtailment actions well ahead of nearby States.

As has been pointed out several times today by Representative Gregg and others there is, in effect, a twin approach being taken on this particular issue. One is the research bill under consideration today and the other is H.R. 4829 which requires a mandatory sulfur-dioxide reduction in a 31-State region over a 10-year period. Recognizing these twin objectives, the Michigan Coalition wishes to express its attitudes not only on H.R. 4830 but to bring to your attention certain efforts by Michigan industry in the control of sulfur dioxide.

Our comments on H.R. 4830 are essentially that the bill is laudable and necessary to provide an understanding on the causes, effects, and control of acid precipitation. If there is one thing that has been made abundantly clear by all segments of society who have expressed views on this subject is that there are myriads of critical questions, many chemical, ecological, meteorological, and economic, that must be answered if this Nation is to respond to the public's concern.

The bill provides an orderly program for procurement of answers to these questions. And importantly, because of the urgency of the issue, the bill sets milestones where assessments are made on the status of our knowledge.

These mandatory periodic assessments are akin to the overall philosophy embodied in the Clean Air Act, that is—specified dates of accomplishment and expected reasonable forward progress toward attainment of the stipulated goals.

Two recently released comprehensive reports with which I am sure this committee is familiar underscore the necessity for accelerated research on acid precipitation. They are the Comptroller General's report and the National Academy of Sciences' report. Although the Academy's report was generally viewed as expressing a clearer understanding on some of the complex issues raised in the Comptroller's report, it also notes, however, a call for much better understanding on some of these same issues.

And within the last few weeks, this committee invited a panel of eight distinguished scientists from the academic and private sector to review their current thinking. The consensus document outlined a list of far-ranging scientific gaps in knowledge.

The message is clear. Achievement of the research objectives of H.R. 4830 is sorely needed.

The coalition felt it would be helpful if the committee and others involved in the acid-precipitation debate became knowledgeable of the efforts undertaken in Michigan by industry and the public utilities to control sulfur dioxide. Unfortunately, it is erroneously thought that sulfur-dioxide emissions are increasing with time when in fact, there have been substantial reductions achieved in the total atmospheric burdens over the past 10 years.

In Michigan, there are two major regulatory programs which brought this about, one at the State level and the other at the county level. As a result of these requirements and subsequent cleanup efforts, the Federal primary- and secondary-ambient-air quality standards for sulfur dioxide have been achieved statewide.

Further, in most areas of the State, including urban centers, ambient-air-quality levels are well within the applicable standards, with most areas showing significant margins of safety. To our knowledge, there are no known major sources of sulfur dioxide in the State which are currently in violation of these emission requirements.

Michigan has adopted and enforced one of the most stringent sulfur in fuel and sulfur-dioxide emission limits in the Nation. The attached tables are indicative of the achievements of Michigan industry.

Table 1 compares the 1975 and 1980 sulfur-dioxide emissions for six Midwest States and the percent decrease—or increase in one case—over this period. You will note, Congressman, that six Midwest States noted and the average reduction from 1975 to 1980 was 16 percent. The State of Michigan reduced their mass rate of emissions by 45 percent.

Other tables compare sulfur-dioxide emissions and the average sulfur dioxide per megawatt-hour for these same States. Michigan's significant accomplishments are readily apparent.

Exhibits 1 and 2 show the efforts of the Detroit Edison & Consumer Power Co. These exhibits clearly indicate a continuing downward trend of emissions amounting to approximately 50 percent in the face of a rise in electrical-generating output.

I might add that just across the river is Canada, and much has been said about Canada today. Ontario Hydro in that same period of time in (1975 to 1980) increased their rate of sulfur dioxide emissions by almost 30 percent.

Almost all of Michigan's major industrial and public utility powerplants are currently burning fuels with less than 1 percent sulfur content. Any further required significant cuts could only be accomplished by addition of scrubber technology, whereas in other States where there is widespread use of much higher sulfur content coals, the reductions could be met by shifting to the less costly route of using lower sulfur fuels.

The coalition feels that Michigan's present aggressive sulfur dioxide control program should be recognized before additional restraints are required in Michigan and until other States achieve comparably low emission levels. Michigan industry is already paying energy costs greater than nearby States as a result of meeting Michigan's stricter sulfur dioxide emission requirements. Any further sulfur dioxide restraints would widen the energy cost differential and put Michigan's already depressed industry at an even further economic disadvantage compared to the other States.

In summary, the Michigan Coalition for Clean Air supports the objectives of H.R. 4830 to provide a systematic approach to resolve the many questions surrounding the acid rain issue.

Thank you very much.

[The prepared statement of Mr. Sterling follows:]

STATEMENT OF MORTON STERLING ON BEHALF OF THE MICHIGAN COALITION FOR CLEAN AIR

MICHIGAN SULFUR DIOXIDE CONTROL EFFORTS

The Coalition felt it would be helpful if the Committee and others involved in the acid precipitation debate became knowledgeable of the efforts undertaken in Michigan by industry and the public utilities to control sulfur dioxide. Unfortunately, it is erroneously thought that sulfur dioxide emissions are increasing with time, when in fact, there have been substantial reductions achieved in the total atmospheric burdens over the past 10 years. In Michigan, there are two major regulatory programs which brought this about one at the state level and the other at the county level.

As a result of these requirements and subsequent clean-up efforts, the Federal Primary and secondary ambient air quality standards for sulfur dioxide have been achieved statewide. Further, in most areas of the State, including urban centers, ambient air quality levels are well within the applicable standards, with most areas showing significant margins of safety. To our knowledge, there are no known major sources of sulfur dioxide in the State which are currently in violation of these emission requirements.

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TABLE 1

MIDWESTERN UTILITIES SO_2 EMISSIONS

SO_2 EMISSIONS*
(1000 tons)

State	1975	1980	Percent Reduction (Increased)
Indiana	1375	1394	(1.4)
West Virginia[1]	977	898	8.1
Kentucky[2]	361	324	10.3
Illinois	1177	1008	14.4
Ohio	2629	2139	18.6
Michigan	987	541	45.2
Total	7506	6305	16.0

Data collected from individual companies' FPC Form 67's.
Illinois data collected directly from individual utilities.

[1] Represents portion of State within ECAR

[2] Data for Kentucky does not include IVA

*Emissions rounded to nearest 1000 tons

TABLE 2

1980 SO_2 EMISSION RATES FROM POWER PLANTS IN MAJOR COAL BURNING STATES

State	Emission Rate lb/MWh
Indiana	42.13
Ohio	38.81
West Virginia[1]	32.75
Illinois	28.72
Kentucky[2]	28.15
Michigan	24.61

[1] Represents only portion of the State within ECAR Region

[2] Does not include TVA

Source: ECAR

To calculate MWh, used coal consumption with conversion factor of 0.87 lb coal/kWh

TABLE 3

1980 COAL DELIVERIES TO STEAM ELECTRIC PLANTS

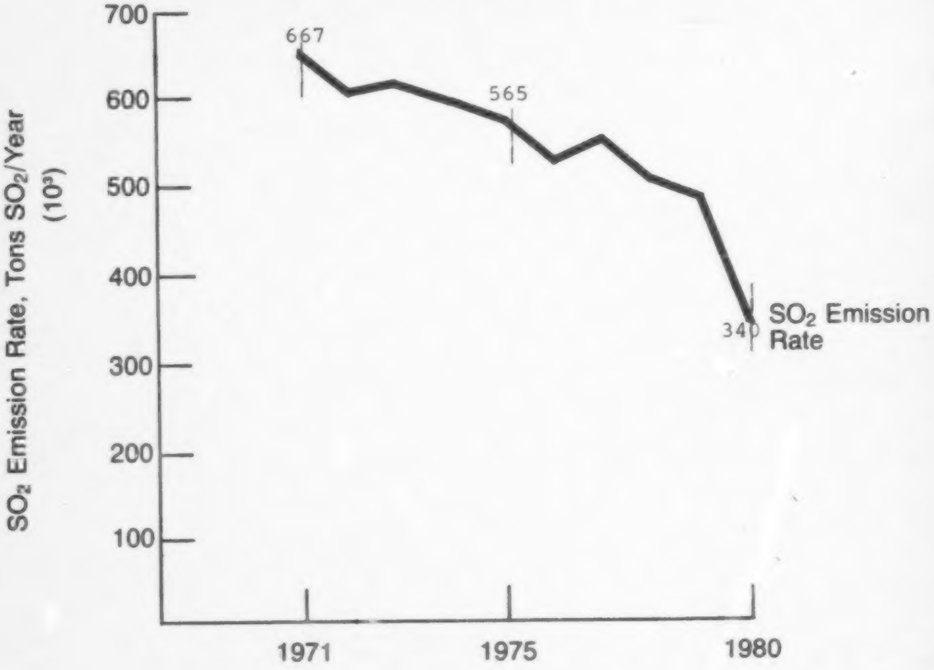
State	Average Weighted Percent of Sulfur in Coal
Indiana	2.62
Kentucky	2.51
Ohio	2.49
Wisconsin	1.87
Illinois	1.84
West Virginia	1.79
Michigan	1.30

Source: Cost of Quality of Fuels for Electric Power Plants

1980 Annual U.S. Department of Energy Report

EXHIBIT 1

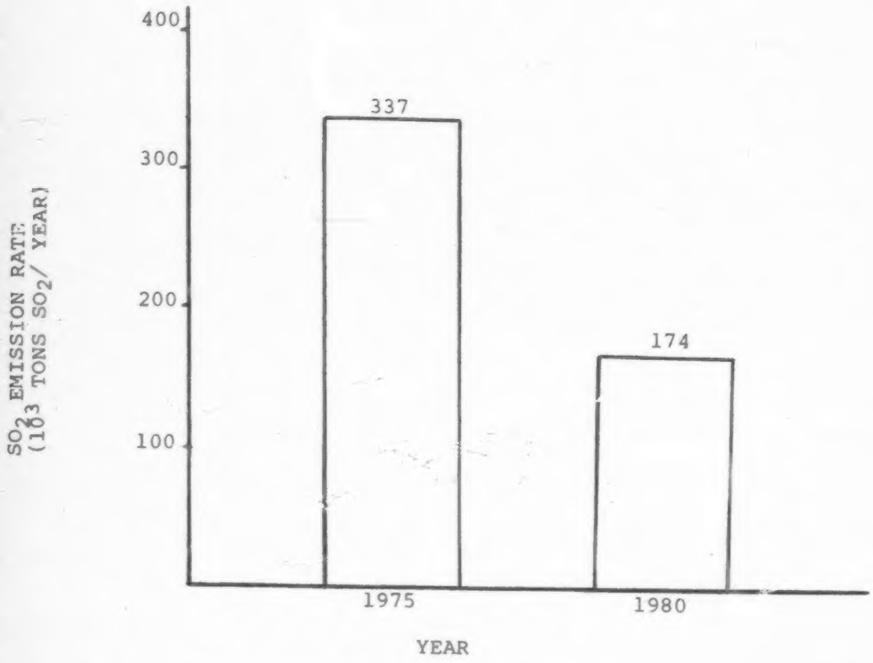
Trend in SO_2 Emission Rate for the Detroit Edison System



SOURCE: DETROIT EDISON COMPANY
DETROIT, MICHIGAN

EXHIBIT 2

SO_2 EMISSION RATE FOR THE
CONSUMERS POWER COMPANY SYSTEM



SOURCE: CONSUMERS POWER COMPANY
JACKSON, MICHIGAN

Mr. **Scheuer**. Well thank you.

I have some additional questions that I will address to each of you in writing

It is now after 5:30. Many of you have been sitting here since 2 o'clock. I thank you very much for your patience. I hereby declare this session adjourned.

[Whereupon, at 5:35 p.m., the subcommittee was adjourned.]

APPENDIX

ADDITIONAL STATEMENTS SUBMITTED FOR THE RECORD

STATEMENT OF CONGRESSMAN DENNIS E. ECKART, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW YORK

I would like to congratulate my distinguished colleague from New York, Mr. Scheuer, for having the determination and foresight to conduct these hearings today on the immensely important yet difficult issue of acid rain. I also thank the subcommittee for permitting me to submit my remarks. Mr. Chairman, I am extremely appreciative of the leadership you have shown in this and other environmental issues affecting our valued natural resources and our health.

As a member of the Foreign Affairs Committee, I am particularly concerned about the international implications of acid precipitation. I recently had the honor of participating in the U.S.-Canada Interparliamentary Group Meeting in Halifax, Nova Scotia. In the report following the meeting, acid rain was described as the single most pressing environmental problem discussed during the session.

In some areas of the Northeastern U.S. and Eastern Canada, the acidity of rain has increased in 25 years to a point where it is now 40 times what was once considered a normal level. It has been estimated that at least one-half of the acid rain falling in Canada originates from emissions released in this country, and that figure is as high as 70 percent in some areas. A large and increasing number of lakes in Canada and the U.S. are now so acidified that they can no longer support fish and related forms of life. Acid rain is believed to be the prime contributor to the extinction of fish life in over 80 lakes in this Adirondack region, and over 40 lakes in Ontario, Canada. Studies indicate a projected loss of more than 48,000 additional lakes in Canada over the next twenty years if this problem continues unabated. Acid rain poses a real threat to property, crops, timber, buildings and monuments, and general visibility.

On July 26, 1979, the Governments of the U.S. and Canada issued a joint statement declaring their intention to move forward with formal negotiations aimed at reaching a bilateral agreement on transboundary pollution. On August 5, 1980, a memorandum of intent was signed by both governments in which they agreed to establish a joint scientific working group in preparation for the start of formal negotiations. The scientific group has been set up, and on June 23, 1981, U.S. representatives met with Canadian officials to formally open these negotiations. The start of these negotiations conveniently coincides with the reauthorization of the Clean Air Act currently underway in Congress. Scientific data of long range air pollution has been more and more available since our clean air laws were first written. It is time to update our laws in keeping with public awareness and scientific evidence on the causes and effects of acid rain.

A diplomatic statement recently issued by the Canadian Embassy focused on the revision of the Clean Air Act by Congress and the administration. The embassy found it necessary, and in fact vital, to again remind the Americans of the importance of the acid rain problem. The statement indicated that "enough is now known about the problem of acid deposition to warrant significant emission reductions. Ongoing research programs in both countries should assist by increasing understanding of the problem and improving means to control it; such research should not however be used as a reason for delay in beginning to take reasonable and effective control action."

The statement concluded that "it has been a tradition of long standing that the United States and Canada seek to consult in advance on proposed policies or actions that may have significant transboundary impact. The Government of Canada therefore requests that no decisions on administration proposals for modifying the Clean Air Act with a potential for worsening transboundary air pollution be taken without prior consultations."

A committee of the National Academy of Sciences released a report earlier this month on the issue of acid rain. The academy's national research council said that emissions of sulfur and nitrogen oxides at current rates "will be extremely risky from a long term economic standpoint as well as from the standpoint of biosphere protection." Additionally, to dispute industry claims of insufficient data, the research council found that the circumstantial evidence linking power plants with the acid rain problem was "overwhelming." They concluded that "the picture is disturbing enough to merit prompt tightening of restrictions on atmospheric emissions from fossil fuels and other large sources such as metal smelters and cement manufacture." The Reagan administration has rejected all suggestions that it tighten pollution standards on fossil fuel plants as a part of its recommendations to congress on changing the Clean Air Act. The administration instead calls only for accelerating research efforts on acid rain.

Scientific evidence, understanding of this problem, and an awareness of its socioeconomic impact, have developed rapidly in recent years. While we can continue to learn about acid precipitation, I strongly believe that now is the time to address this environmental problem. We owe it to our citizens, to the continuation of our commitment to a healthly environment, and to our mutual obligations with Canada.

STATEMENT OF GLORIA DAVIS, MEMBER, NEW YORK STATE ASSEMBLY, CHAIRWOMAN, SUBCOMMITTEE ON AIR QUALITY

I currently chair the Air Quality Subcommittee of the New York State Assembly. Acid rain is one of the most pressing air quality concerns facing New York; I am pleased to see that Congress is attentive to this issue and I thank Congressman Scheuer and the Subcommittee on Natural Resources, Agriculture Research and Environment for the initiative they have shown in bringing us together for this hearing.

Although my main concern as chairwoman is the air quality of New York State—and acid rain certainly has an air quality impact—I want to stess, the important connections between environmental problems in the air, and many other environmental, social and economic concerns. For I'm afraid that by chopping up our world into small manageable bits and pieces we often overlook—and find ourselves unprepared to deal with—the complicated problems that don't fit neatly into any of our predesigned packages.

Acid rain is a primary example. Somehow, when we passed the Clean Air Act, we forgot that air moves around, it travels freely between air quality regions, between states and from country to country. And we seemed to think that by sending our emissions up taller and taller smokestacks, all that pollution was simply disappearing. Now we know better—it's not disappearing, it's reappearing, as acid rain in Ontario, here in the Adirondacks, all over New York and in most of the Eastern states.

Nor is acid rain affecting just the air. Our dead lakes are a grim reminder that air and water can't be treated as separate environmental boxes. What we put in the air gets into water and affects our lakes; gets into soil and affects our precious land; gets into our lungs and affects our health.

Nor is acid rain an isolated matter of environmental policy. Air pollution is directly related to our national energy policy. The amount of fuel we burn and the types we use have a direct affect on the amount and type of pollution we emit into the environment. We are now striving for energy independence—this is a wise and a necessary thing to do—but certainly, at the same time, we can apply our collective efforts to maintain and improve our environmental quality. Burning more coal does not have to mean releasing more pollution. We have the technological skill to apply effective controls—what we need is the national will to do so. And energy independence does not have to mean dramatic increases in fuel consumption; conservation is an attractive, sensible and effective means of achieving energy independence without sacrificing environmental quality.

And finally—as we can see by the many representatives here today—acid rain is a complex interwoven political problem. No single state can find a comprehensive solution, although the solution will eventually rest with the policies of many states. Even our federal government is not of a grand enough scale to handle this international problem—we will need to see an unprecedented amount of cooperation between states, provinces and the federal governments of the United States and

Canada if we are going to deal with acid rain in a manner that is fair to all affected parties. I feel confident that we will find ourselves up to the task.

STATEMENT OF DR. ELLIS B. COWLING, CHAIRMAN, NATIONAL ATMOSPHERIC DEPOSITION PROGRAM, ASSOCIATE DEAN FOR RESEARCH, SCHOOL OF FOREST RESOURCES, ASSISTANT DIRECTOR, NORTH CAROLINA AGRICULTURAL RESEARCH SERVICE, NORTH CAROLINA STATE UNIVERSITY, RALEIGH, N.C.

DEVELOPMENT OF AN ACID-RAIN MANAGEMENT PLAN

The following list contains a suggested sequence of steps for the evaluation of alternative strategies for the management of acid rain and its biological and water quality effects:

(1) Determine the geographical location of sensitive natural resources and materials (lakes, streams, crop lands, forests, man-made structures, etc.) which are now being affected by acid precipitation or may be affected in the future.

(2) Identify those resources which society wishes to protect.

(3) Conduct a comparative analysis of various strategies by which the protection desires by society might be achieved. Alternative strategies would include the following: (a) decrease the amount of emissions leading to acid deposition; (b) use ameliorative treatments such as liming of lakes or application of protective coatings to materials; or (c) develop acid-tolerant forms of life and structural materials.

(4) Assuming that decreased emissions is the alternative of choice, as suggested in the recent Atmosphere-Biosphere Report of the National Academy of Sciences, determine the amount by which acid deposition will need to be decreased in order to avoid undesired effects on the resources selected for protection.

(5) Determine where and by how much emissions of acid rain percursors will have to be decreased in order to achieve the extent of decrease in deposition that will be required in the regions selected for protection.

(6) Evaluate specific management strategies and tactics by which each selected source region could do its part to achieve the total emissions decrease that would be necessary. Possible methods would include the following: (a) conserve fossil fuels; (b) alter the mix of energy sources to include a higher proportion from non-polluting sources such as solar or possibly nuclear; (c) use some combination of fuel cleaning, combustion modification, flue-gas treatment, etc. and (d) alter regulations to include existing as well as new sources, encourage "least-emissions-dispatching," permit the purchase and exchange of "pollution dispatching," etc.

Each of these suggested steps involves uncertainties that are analogous with those that surrounded the debates about the role of phosphorous in the euthrophication of Lake Erie in the early 1970's. The experts then could not agree. Some said a 40 percent decrease in loading would be needed. Others said 75 percent. Still others said nitrogen was to blame, not phosphorous. Environmentalists warned of "possible irreversible damage." Industry said more research was needed. Finally a political decision was reached—a plan should be developed. More debates were held. A theoretical model was used to predict that a 50 percent decrease in loading might be sufficient. Under conditions of substantial uncertainty a management plan was finally implemented. After some time Lake Erie began to improve. The theoretical estimate was too low but with some further adjustments the plan worked and Lake Erie is now on the road to recovery.

After a decision is made to proceed with preliminary evaluation of policies to protect sensitive regions from acid deposition, it probably will take at least five years to debate the scientific and management issues sufficiently to formulate an appropriate management plan. Also, at least another five years probably will be required to achieve an actual reduction in emissions. During the period of debate, new biological, atmospheric chemical, and meteorological insights will be developed which will help refine whatever management strategies may be recommended. Therefore, it seems prudent that we begin this debate and evaluation now, recognizing that research is continuing and that a decision to continue with present policies is one among many possible alternatives.

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THE ADIRONDACK COUNCIL'S POSITION ON ACID RAIN AND THE CLEAN AIR ACT

July, 1981

For Further Information
Contact: Gary Randorf
518-873-2240

Over the past few decades the acidity of rainfall in the Northeast and apparently much of the U.S. and Northern Hemisphere has increased dramatically. There is little doubt that the acidity is in excess of what aquatic and terrestrial ecosystems can bear without suffering grave consequences. In the Adirondack Park of New York State (a vast six-million acre area comparable in size to the entire state of Massachusetts) almost 300 lakes have been acidified to the point of supporting little, if any, aquatic life. Additionally, reduction in the growth of forests is highly probable, and it has been learned that a number of people are consuming drinking water that is high in copper and lead, leached out of domestic and commercial plumbing systems by acidic water supplies. The tiny sulphate particles that substantially contribute to the formation of acid rain are part of the fine particulate mass that invades human lungs to adversely affect persons with bronchial disorders and respiratory diseases. For an area so economically dependent upon tourism and the forest products industry, the outlook for the future of the Adirondacks is dim unless a permanent solution to reduce acid rain levels is forthcoming. Initial steps to control acid rain can and must be taken when the Clean Air Act is re-authorized in the coming months.

Areas like the Adirondacks, whose soils and waters have limited ability to neutralize acid and are downwind of major sources of certain air pollutants (particularly sulphur dioxide and nitrogen oxide) that contribute to the formation of acid rain are the first to be negatively affected. Over time, however, it is recognized that additional areas have and will experience acidified waters and become vulnerable to reduced forest and agricultural crop growth and be subjected to serious human health concerns.

The only permanent solution to the acid rain problem is to keep acid levels low. The only practical way to do this is to change energy use patterns--through conservation or the use of non-polluting sources--and to stop emissions at the major sources. Those from coal-burning plants can be controlled by using low-sulphur fuels, by removing the sulphur from the fuel before it is burned, and/or by "scrubbing" the gases in the smokestacks. The Adirondack Council strongly recommends the U.S. makes a commitment to the widespread use of scrubbers. Japan has over 1,000 scrubbers installed in that country and in a five-year period reduced its SO_2 level by 50% while its level of energy consumption was increasing by 125%. There are several methods for controlling emissions from non-ferrous smelters.

Member Organizations: The Association for the Protection of the Adirondacks; National Audubon Society; The Natural Resources Defense Council; The Wilderness Society

Many scientists believe that effective controls can be applied now and they should be as we already know that sulphur and nitrogen oxides are causing extensive damage.

The only way to achieve the necessary levels of control of acid rain is to have national standards in the Clean Air Act that would establish limits on emissions from the source on old as well as new power plants, smelters, etc. Because of long-range transport of pollutants that cross state, national, and even international boundaries it is counterproductive to try to address the acid rain problem on the state level. If the U.S. addresses the problem nationally it can then take the lead in striving internationally to achieve emission reductions in the major industrialized, polluting countries. Additionally, because of long-range transport, the construction of excessively high smokestacks should cease because this only transfers the problem to a different geographical area and is analagous to pumping raw sewage through a straight pipe to some other area and having that area deal with the problem.

How many more lakes have to die before we get the message? If we fail to act now we may achieve a more complete understanding of the acid rain phenomenon but will risk having what New York's Environmental Commissioner has referred to as the "best researched environmental disaster in history."

The environment and human health in the Adirondack Region is at stake if the Clean Air Act doesn't adequately address acid rain at a national level, and the economy of this vast area of New York State will be sacrificed for the economic benefit of states upwind, particularly in the Ohio River Valley.

If the economic burden is too great for the electrical generating facilities and other major emission sources to implement the necessary level of control then some way must be found to provide financial assistance that can be shared by all consumers, who will surely benefit by controlling acid rain now. Waiting to do something at some future time will bring disaster and a much greater cost for control.

A recent Harris Survey (June 1981) shows that 86% of the American public opposes making the provisions of the Clean Air Act less strict, and almost half of those feel the Act should be made stricter.

The Adirondack Council is a coalition of four conservation organizations (National Audubon Society, Natural Resources Defense Council, Wilderness Society, Association for the Protection of the Adirondacks) and 2,000 individual members, dedicated to preserving the natural character of the Adirondack Park for present and future generations.

ADDENDUM TO REPORT "THE CASE AGAINST THE RAIN"

Ontario Hydro to reduce SO_2 and NO_x Emissions Under $500 Million Program as Part of Environment Ontario Regulation

Since publication of this report, the Ontario Government announced on January 26, 1981 proposed regulations for the substantial reduction of sulphur dioxide (SO_2) and nitrogen oxide (NO_x) emissions from Ontario Hydro's coal-fired electric generating plants.

Ontario Hydro is second only to Inco Ltd. as the largest source of SO_2 within the Province and is the largest industrial source of NO_x. Its coal-fired stations (see pages 12 and 13) produce about 20 per cent of total emissions of these two pollutants in the Province, but are not large producers compared with similar sources in the United States.*

The regulation will limit SO_2 emissions per annum to 390,000 metric tons beginning in 1985, dropping to a permanent ceiling of 260,000 metric tons by 1990 -- a reduction of 43 per cent. That percentage figure was derived by averaging the emissions of 1979 (437,000 tonnes) and 1980 (410,000 tonnes) and the projection for 1981 (509,000 tonnes) and comparing it with the 1990 target (260,000 tonnes). The reductions are based on a 3.1 per cent annual increase in electricity demand, and the limits are set regardless of growth factors.

In addition, the regulation will require Ontario Hydro to install low NO_x burners on its larger coal-fired stations. This action should result in a maximum of roughly 60,000 metric tons of NO_x in 1985, and about 40,000 metric tons in 1990. The amount of tonnage will also drop between 1985 and 1990 because less coal-fired generation will be occurring at the end of this decade.

Additionally, Environment Ontario and Hydro are immediately taking steps to implement a new operating philosophy designed to minimize atmospheric emissions from Hydro's three largest coal-fired stations -- Nanticoke, Lambton and Lakeview. These three plants account for more than 90 per cent of Hydro's SO_2 and NO_x emissions.

The name of this operating philosophy is the "Least Emissions Dispatching System (L.E.D.S.)". This concept is being considered by the U.S. government. If implemented, it would lead to significant reductions in emissions from existing plants, without the use of any additional pollution control equipment or special fuels. Under the L.E.D.S. philosophy, a utility generates power from its "cleanest" plants first, and its "dirtiest" plants last. This ensures that plants already having pollution control measures are utilized fully, and not allowed to stand idle.

The proposed program places Hydro in the forefront of acid rain pollution control in North America. Hydro will be the first in Canada, and one of the first major utilities on this continent to retrofit plants with large-scale SO_2 scrubbers for the sole purpose of combating acid rain. Hydro will install two 500 mw scrubbers. Hydro's plants already meet all ground level ambient air requirements.

Also, Hydro's low NO_x burner research program is considered one of the first programs of its kind undertaken by a major utility in North America. It places Hydro in the forefront of nitrogen oxides pollution control.

In a statement announcing the new Hydro regulations, Ontario Environment Minister Harry C. Parrott expressed the hope that Ontario's actions would help in the current Canada/U.S. negotiations on acid rain:

> *"U.S. power utilities account for the major share of our neighbor's emissions...*
>
> *"With the substantial increase in the use of coal as an energy source in the United States, and the projected increases in SO_2 and NO_x emissions in the U.S. between now and the year 2000, controls are vital to the protection of our environment in Eastern Canada. This point is made vividly by a recent EPA report**. It states that because of tall stacks and prevailing weather conditions, Canada receives from the U.S. two to four times as much SO_2, and 11 times as much NO_x as the U.S. gets from Canada.*
>
> *"One of the weaknesses of the U.S. situation, is their failure to come to grips with the question of retrofitting. Their regulations require only new utility plants to achieve this degree of cleanliness in sulphur dioxide emissions, and then only to meet local ambient air requirements. Their laws are not geared to solving the acid rain problem.*
>
> *"...with Ontario Hydro's three biggest coal-fired plants operating along the lines of L.E.D.S., the example will be set for other utility systems in Canada and the U.S. to follow our lead. To show you how effective this operating philosophy is, an analysis of a recent report presented to the U.S. EPA*** shows that in the region containing most of Illinois, Indiana, Ohio, Kentucky and West Virginia, as well as the southwest part of Pennsylvania, a reduction of approximately 20 per cent in SO_2 emissions would occur if L.E.D.S. was implemented.*
>
> *"...it is obvious, therefore, that while Ontario can provide leadership in tackling this costly abatement program, our efforts to reduce acid rain will be of little consequence unless our neighbors to the south follow our lead now.*
>
> *"To delay means inevitable -- perhaps irreversible -- damage to the natural environments of Ontario, Canada and the United States."*

---

*Ohio's 11 largest thermal power plants, alone, emit more SO_2 per annum (2.3 million tons) into the atmosphere we share than all of Ontario's sources combined (1.5 million tons per annum), including Inco Ltd. in Sudbury.

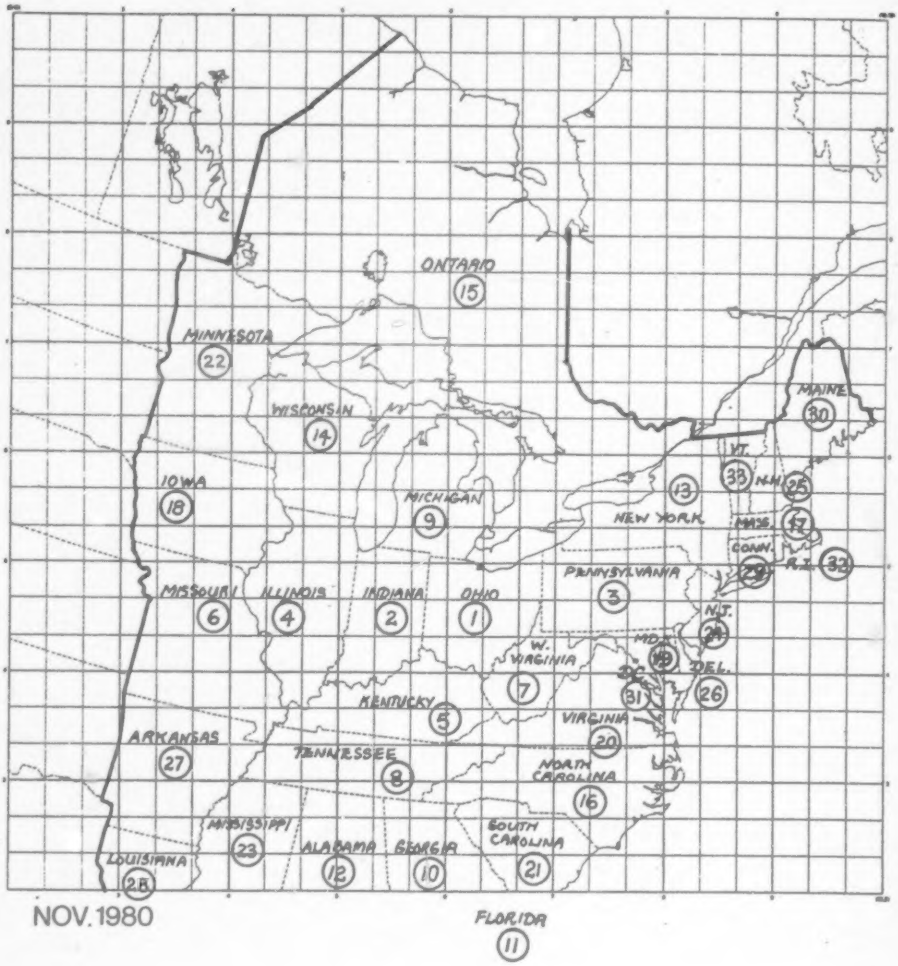
**"Acid Rain", U.S./EPA Office of Research and Development, July 1980, Report number EPA 600/9-79-036.

***"The ORBS (Ohio River Basin Study) Main Report" December 1980, U.S. EPA Office of Research and Development, Dr. L Smith, project officer.

ERRATUM: Page 7 - "Major SO_2 and NO_x Emitting Areas" -- geographical area #10 should read "East Missouri", not "East Montana".

1979 ranking of states and Ontario according to SO_2 emissions from power plants.

Source: U.S. Department of Energy data as computed by Environment Ontario.


ONTARIO 15
MINNESOTA 22
WISCONSIN 14
IOWA 18
MICHIGAN 9
NEW YORK 13
MAINE 30
VT. 33
N.H. 25
MASS. 17
CONN. 29
R.I. 32
PENNSYLVANIA 3
MISSOURI 6
ILLINOIS 4
INDIANA 2
OHIO 1
N.J. 24
MD. 19
D.C. 31
DEL. 26
W. VIRGINIA 7
KENTUCKY 5
VIRGINIA 20
ARKANSAS 27
TENNESSEE 8
NORTH CAROLINA 16
MISSISSIPPI 23
ALABAMA 12
GEORGIA 10
SOUTH CAROLINA 21
LOUISIANA 28
FLORIDA 11

NOV. 1980

TOP 50 COAL-FIRED POWER PLANTS IN EASTERN NORTH AMERICA RANKED ACCORDING TO TOTAL SO_2 EMISSIONS IN 1979

RANK	PLANT	STATE	COUNTRY	ESTIMATED SO_2 EMISSION THOUSANDS OF METRIC TONS/YEAR
1	PARADISE	KENTUCKY	U.S.A.	372.5
2	MUSKINGUM	OHIO	U.S.A.	340.2
3	GAVIN	OHIO	U.S.A.	339.5
4	CUMBERLAND	TENNESSEE	U.S.A.	289.7
5	MONROE	MICHIGAN	U.S.A.	264.8
6	CLIFTY CREEK	INDIANA	U.S.A.	263.7
7	GIBSON	INDIANA	U.S.A.	261.1
8	BALDWIN	ILLINOIS	U.S.A.	257.9
9	LABADIE	MISSOURI	U.S.A.	224.0
10	KYGER CREEK	OHIO	U.S.A.	205.5
11	BOWEN	GEORGIA	U.S.A.	202.6
12	CONESVILLE	OHIO	U.S.A.	186.8
13	MITCHELL	WEST VIRGINIA	U.S.A.	186.2
14	HATFIELDS	PENNSYLVANIA	U.S.A.	167.3
15	NEW MADRID	MISSOURI	U.S.A.	164.0
16	SAMMIS	OHIO	U.S.A.	160.7
17	LAMBTON	ONTARIO	CANADA	160.2
18	WANSLEY	GEORGIA	U.S.A.	159.7
19	HOMER CITY	PENNSYLVANIA	U.S.A.	159.1
20	JOHNSONVILLE	TENNESSEE	U.S.A.	157.9
21	NANTICOKE	ONTARIO	CANADA	155.0
22	GASTON EC	ALABAMA	U.S.A.	154.8
23	MONTROSE	MISSOURI	U.S.A.	147.1
24	HARRISON	WEST VIRGINIA	U.S.A.	142.8
25	BRUNNER ISL.	PENNSYLVANIA	U.S.A.	142.0
26	COFFEEN	ILLINOIS	U.S.A.	141.8
27	CARDINAL	OHIO	U.S.A.	140.8
28	EASTLAKE	OHIO	U.S.A.	137.4
29	KAMMER	WEST VIRGINIA	U.S.A.	136.8
30	KINCAID	ILLINOIS	U.S.A.	136.3
31	KEYSTONE	PENNSYLVANIA	U.S.A.	127.2
32	STUART J.M.	OHIO	U.S.A.	125.6
33	CAYUGA	INDIANA	U.S.A.	121.7
34	SHAWNEE	KENTUCKY	U.S.A.	111.0
35	GALLATIN	TENNESSEE	U.S.A.	110.6
36	MONTOUR	PENNSYLVANIA	U.S.A.	109.4
37	BIG BEND	FLORIDA	U.S.A.	109.2
38	CONEMAUGH	PENNSYLVANIA	U.S.A.	108.9
39	WIDOWS CREEK	ALABAMA	U.S.A.	106.0
40	AMOS	WEST VIRGINIA	U.S.A.	105.2
41	THOMAS HILL	MISSOURI	U.S.A.	104.9
42	JOPPA STEAM	ILLINOIS	U.S.A.	104.4
43	MT. STORM	WEST VIRGINIA	U.S.A.	102.5
44	PETERSBURG	INDIANA	U.S.A.	100.7
45	BECKJORD	OHIO	U.S.A.	99.7
46	AVON LAKE	OHIO	U.S.A.	96.0
47	FORT MARTIN	WEST VIRGINIA	U.S.A.	94.6
48	MIAMI FORT	OHIO	U.S.A.	94.2
49	LAKEVIEW	ONTARIO	CANADA	91.4
50	YATES	GEORGIA	U.S.A.	88.8

POWER PLANTS WERE CONSIDERED FROM ONTARIO AND 32 EASTERN U.S. STATES. THE STATISTICS ARE FROM ONTARIO HYDRO AND THE U.S. DEPARTMENT OF ENERGY; THE ANALYSIS WAS PERFORMED BY THE ONTARIO MINISTRY OF ENVIRONMENT, AIR RESOURCES BRANCH.

Acid Rain and Gray Snow

From:
Natural History, Feb. 1981
(Reproduced with permission)

In many parts of the world, rain is no longer gentle and snow no longer white

by George R. Hendrey

Mountain lakes and streams, long regarded as symbols of purity, are becoming increasingly contaminated by atmospheric pollution. Rain and snow that have become loaded with toxic chemicals, mainly acids, have been falling over nearly all of the eastern United States, southeastern Canada, northern Europe, and southern Scandinavia. More recently, California, Colorado, and Washington State have been added to the list of regions known to be receiving acidic precipitation. In many places, the rain is so polluted that numerous species of freshwater animals would be killed if they were exposed directly to water having its average chemistry.

The pollution is caused primarily by the combustion of large amounts of fossil fuels—coal, oil, and gas. Oxides of sulfur and nitrogen created in the combustion process are released into the atmosphere, where they react with oxygen, water, and other substances in the air to form sulfuric acid and nitric acid. These two pollutants are what cause the rain to be so acidic.

In 1940, about 22 million tons of sulfur oxides and about 6.7 million tons of nitrogen oxides were spewed into the atmosphere from American homes, factories, and power plants. By 1976 these emissions had risen to 32 million tons of sulfur oxides, a 45 percent increase, and 25 million tons of nitrogen oxides, a 273 percent increase. Large increases in power plant emissions of sulfur oxides during this period were partly offset by decreased

Streams in certain mountainous areas, including the Adirondacks, are particularly sensitive to acidification. The drainage basins of such streams typically have relatively little soil cover and a minimum of minerals capable of neutralizing the acidity of precipitation.

emissions from other industries and from homes and businesses that shifted from coal to oil or gas. The total amount of sulfur oxides released into the atmosphere therefore did not increase as dramatically as the amount of nitrogen oxides. The increased nitrogen oxide emissions were primarily from motor vehicles, factories, and power plants, in that order.

Ironically, the installation during this time of extremely tall smokestacks at some power plants often helped to transform a local problem into a regional one. The tall stacks emit large amounts of pollutants high into the air where they are carried long distances by the wind, thereby gaining more time in which to react chemically to form sulfuric and nitric acids.

There is little evidence so far that airborne acidity has injured crops and forests, but the evidence of environmental damage in freshwater lakes and streams in severely affected regions is unmistakable. Some lakes are more susceptible to acid precipitation than others. Among the factors that determine the extent to which a lake may become acidified are the amounts of acid or acid-forming materials that are deposited, the sensitivity of the soil and bedrock to acidification, and the topography of the watershed.

When scientists speak of a lake being acid, they are referring specifically to the concentration of ionized hydrogen in the water. In chemical shorthand, this form of hydrogen is specified as H^+. The presence of H^+ is what gives solutions their acidity.

For the sake of convenience, the concentration of H^+ is often expressed in terms of the pH scale. The scale is logarithmic, so that a rise or fall of one pH unit represents a tenfold change. Thus, pH6 is ten times more acidic than pH7, and pH5 is a hundred times more acidic than pH7. In unpolluted, clear, natural waters, the pH level is rarely below 6.

In neutral water (with a pH of 7), the H^+ concentration is very low, about one-tenth part of H^+ to a billion parts of water, or 0.1 parts per billion (ppb). Pure water, which is in equilibrium with the atmosphere, will have carbon dioxide dissolved in it, making a slightly acidic solution of pH5.6, or 2.5 ppb. This is often referred to as the pH of "unpolluted" rain. Many lakes that have been acidified by acid rain now have concentrations of 30 parts of H^+ per billion parts of water—300 times the concentration of acid in neutral water. We know that the concentration of H^+ in rain in the northeastern United States is sometimes as high as 3,000 ppb, which is 30,000 times as high as neutral water and more than 1,000 times more acidic than "unpolluted" rain.

The ability of water to neutralize H^+ is called its buffer capacity, and it is determined, for the most part, by the alkalinity of the water. Alkalinity, in turn, comes primarily from the weathering of minerals in the watershed. Limestone and other, similar minerals are the most important substances that provide alkalinity and, hence, buffering capacity.

As acidification proceeds, the alkalinity is removed in the form of carbon dioxide and lost from the water. This diminishes the water's acid-neutralizing capacity. When acids deposited from the atmosphere percolate through a watershed, aluminum is also dissolved from soil and rocks. Hydrogen ions are exchanged for aluminum ions in the minerals of soil and rocks. By decreasing the amount of H^+, this process may decrease acidity, but aluminum can be a threat to fish. Aluminum concentrations, which are usually well below 0.1 parts per million (ppm) in lakes and streams, are greatly elevated through the exchange of H^+ in regions with very acidic precipitation. Acidified waters in the Adirondacks, for example, have concentrations of 0.2 to 1 ppm of aluminum. At 0.2 ppm, aluminum is quite toxic to fish.

Most of the regions in which lakes and streams are acidified have thin soils and relatively large amounts of

George R. Hendrey

exposed bedrock. In these areas the chemical characteristics of the bedrock determine the fate of the acids deposited from the atmosphere. Limestone terrain has a nearly infinite ability to buffer H⁺, but hard crystalline rocks such as granites contain no minerals that could contribute alkalinity, are slow to dissolve, and therefore have little ability to neutralize acids.

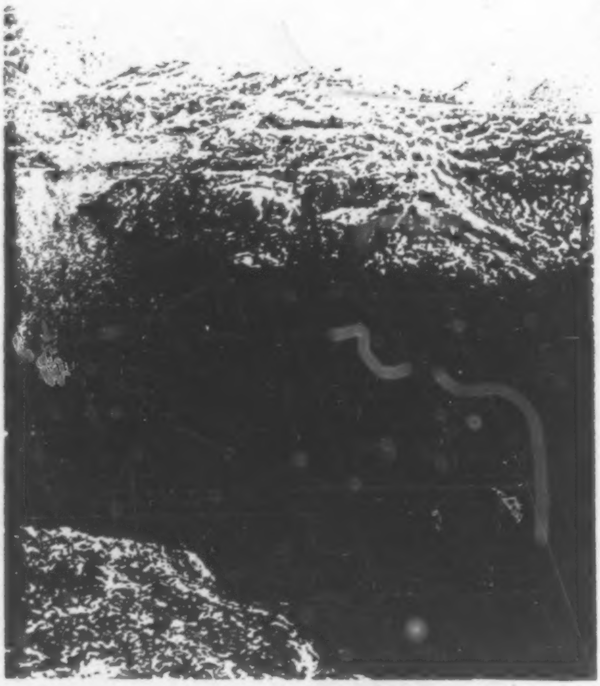
The freshwater regions of North America where acidification is most severe are the Canadian Shield and the Adirondack Massif. In less sensitive regions the bedrock is more extensively covered by soil, derived either from the local bedrock by means of erosion or transported into the area by water, winds, glaciers, or landslides. A transported soil, in contrast to local soil, may be quite different from the bedrock under it, and deep soils as well as shallow ones can be transported. Nevertheless, whatever the source, the deeper the soil, the greater the possibility of contact with water passing through it. Therefore, even soils with little buffering capacity can, if they are deep enough, neutralize acidic precipitation.

The topography of a region has an important influence on the susceptibility of its lakes and streams to acidification. Mountainous areas, for instance, are likely to have shallower soils and more exposed bedrock than lowlands. Many mountain streams have little water and sometimes dry up. Close to the top of their watershed, these streams get relatively little ground water and, since they swell rapidly during small rainstorms, are in many cases vulnerable to the chemical effects of rain. Studies conducted last year in the Shenandoah National Forest by James Galloway of the University of Virginia show this to be true for some streams in the Blue Ridge Mountains of the southeastern United States. Before these studies, this region was not known to have been affected by acidic precipitation.

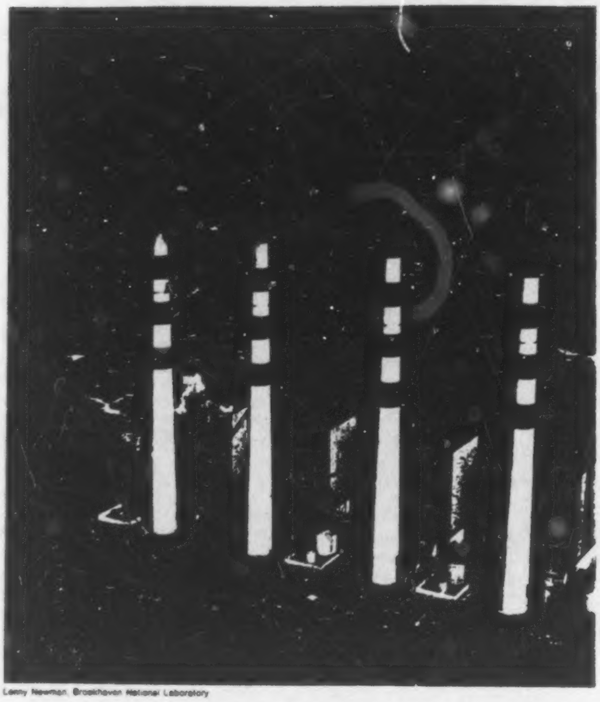
Another way in which topography influences lake and stream acidification is by increasing the amount of precipitation they receive. When bodies of air moving across lowlands encounter a mountainous region they are forced to rise. As they rise, they encounter diminishing atmospheric pressures, and the air expands to occupy a larger volume with the same mass. The heat contained in the rising air parcel is also distributed throughout a larger volume, so that the temperature of the air decreases. This cooling process is what causes clouds to form and rain to fall more frequently over the mountains than over lowlands. The first rain that falls after a body of cooled air has passed through a mountainous region tends to remove more pollutants than subsequent rainfalls do, thereby causing the mountains nearest the source of the acidic air pollution to receive more acid than neighboring areas.

In 1979 a computerized inventory of water chemistry data from the eastern United States was set up at Brookhaven National Laboratory on Long Island. Known by the acronym ACID (for Acidification Chemistry Information Database), this inventory reveals that waters with low alkalinities (that is, less than 100 ppb) are found in many areas of the eastern United States. A large number of such headwater streams have probably become at least temporarily acidified by rain or snow that is strongly acidic.

Abundant snow is a feature common to the geographical regions most heavily affected by acidification. But much of the snow is no longer pure. Like the rain, it carries a burden of pollutants released by humans into the atmosphere. In fact, falling snow is



The lakes and streams of southern Norway began to lose their fish populations decades ago. There are now thousands of lakes in this region from which fish have been completely eliminated.



The installation of tall smokestacks at power plants, beginning in the 1950s, allowed emitted sulfur oxides to spread more widely before being deposited, providing time for greater portions to be converted into sulfuric acid. Such airborne acid can fall as acid rain hundreds of miles from the source of pollution.

Lenny Newman, Brookhaven National Laboratory

sometimes a dirty gray. And not just in industrial towns, but in areas such as south-central Norway, many hundreds of miles from the sources of the pollutants. Snow cores taken from that region of Norway contain gray bands corresponding to specific snowstorms that carried fly ash and other contaminants east and northward from the industrial regions of Great Britain and the rest of Europe. I have not yet seen this kind of banding in the snows of the Adirondack Mountains, probably because of the relatively stringent rules concerning airborne emissions of particulate pollutants in the United States. Some American snow, however, like the snow in Norway, is contaminated with acids.

When rainwater freezes to form sleet, the ice crystals created in the process tend to exclude molecules of all substances other than water. A water droplet containing sulfuric acid will thus become a small clump of ice covered with the droplet's total amount of acid. The acid on the outside of the tiny clump is accordingly in a more concentrated form. Furthermore, ice and snow crystals serve as attachment sites for sulfur and nitrogen oxides, where the adhering oxides can react with other pollutants and water. When the sleet or snow falls to the ground, the pollutants stay bound to the outside of the crystals. As the snow pack ages, a slight melting and recrystallization take place, increasing the size of the ice particles. Since pollutants continue to be excluded from the crystals, they become even more concentrated on the outside of the ice particles. If the partial melting occurs above a layer of solid ice in the snow pack or on a lake, one or more bands of concentrated pollutants may be formed within the snow pack.

As soon as enough melting takes place to allow water to move freely through the snow, the first meltwater will remove a large portion of all of the soluble pollutants. Researchers at the Norwegian Institute for Water Research have shown that this mechanism typically removes 50 to 80 percent of the pollutants in the first 30 percent of the meltwater. The sudden release of acids and other pollutants from snow that has collected for weeks or months can cause drastic acidification in lakes and streams. An example of this process can be found in Panther Lake in the western Adirondack Mountains of New York State. The lake usually has a pH of slightly above 7, almost neutral. But when the snow melted in the spring of 1979, the pH dropped to about 5, an increase in ionized hydrogen of about a hundredfold.

The cause and effect relationship between acid rain and the disappearance of fish was first suggested by a Norwegian fisheries inspector in 1959. It was publicized in Norway in 1966 and has subsequently been well documented. Concern about acid rain was not felt anywhere until Scandinavian scientists began to notice that many lakes and streams in southern Norway and on the west coast of Sweden were losing their populations of fish. The decline in the salmon catch in major rivers of southern Norway is most striking. The Tovdal River salmon catch began an unprecedented decline in the late 1920s. Periodic fish kills, which may have been caused by drops in the springtime levels of pH, possibly combined with simultaneous increases in the concentration of aluminum, gradually reduced the stock of Atlantic salmon in the river (although other factors such as overfishing might also have played a role and cannot be completely disregarded). The scientific documentation for this period is poor, since few pH measurements in streams were made. We do know, however, that in the past two decades the entire Tovdal River, with pH values in the range of 4.6 to 5.2 in 1975, has become so acidic that throughout most of the year Atlantic salmon cannot survive in its waters. These low pH values are in marked contrast to those in Norwegian rivers beyond the reach of airborne acid.

In 1975, Carl Schofield, a fisheries biologist at Cornell University, conducted a survey of 217 Adirondack shrimp (*Lepidurus arcticus*). Ordinarily, this organism undergoes a rapid series of molts as it progresses from the egg to maturity. My studies show that a pH of 6, which is only slightly acidic, delays the normal rates of progression through this series of distinct life stages and more and more of the animals die before becoming adult. As the pH level decreases, interference with the progression of life stages and premature death both increase. Another common invertebrate, the freshwater scud gammarus (*Gammarus lacustris*), is also absent from waters with a pH level below 6, and my research has shown that even gammarus adults cannot tolerate a decrease in pH much below the 6 level. Immature stages of this scud would probably be even more sensitive to high acidity.

Animal life of all kinds in lakes and streams, from fish down to the smallest invertebrates, depends upon energy from food, which is derived either from plants growing in the water or from organic litter such as leaves and twigs transported by the wind or the flow of streams. In streams and small lakes or ponds, plant litter is the most important food source for animal life. Ecologists have shown, however, that bacteria and fungi are very important in making these sources of food available to animals, and many invertebrates obtain more energy from eating these microdecomposers than from eating the leaves or other detritus with which the microbes are associated. Decreasing this microbial activity may therefore have profound effects throughout the food web of a stream or lake.

Investigators working in the 1970s observed abnormal accumulations of organic litter in Swedish lakes. The suspected cause was inhibited decomposition due to low pH levels. Several other concurrent studies in North America and Scandinavia, including experiments in stream acidification and lake neutralization, indicate that microbial decomposition is retarded by acidification.

Small algae that live suspended in the water of a lake are called phytoplankton. By means of photosynthesis, these plants reproduce themselves, creating new organic material in the water, a process known as primary production. This process is one of the basic steps in providing energy from food for the animals of a lake. We have already seen that the number of species of phytoplankton is reduced by acidification, but we do not know whether acidification also alters the process of phytoplankton production.

The production of phytoplankton is regulated by the availability of both sunlight and nutrients. In lakes that are sensitive to acidification, the critical nutrient is phosphorus, a key substance regulating plant growth. When the effects of acidification on phytoplankton production in different lakes are compared, it is difficult to tell whether the differences are due to the acid itself, to the presence of other material, such as aluminum, that is increased due to the acid, or to the low availability of nutrients. For most lakes that are susceptible to acidification, the susceptibility arises from their low concentrations of essential nutrients and of various chemicals, such as calcium, magnesium, and bicarbonate. Acidification appears to retard the exchange of nutrients between sediments, decomposing litter, and the water, however, and so in the presence of acidification, nutrients are probably even less readily available. The acidification of watersheds also releases aluminum into the ground water, and aluminum can bind to phosphorus, preventing it from moving through soils. By this process, the supply of phosphorus in streams and lakes may possibly be reduced in acidified watersheds, which would reduce phytoplankton growth. If acidification does reduce phytoplankton production, then part of the foundation of animal life and, consequently, the supply of food for fish, would be reduced.

A side effect of lake acidification is to make lake water clearer. This may result from the acid reducing the brownish color of natural humus materials in the water, from a reduction in the density of algae in the water, or from some combination of these two factors. Algal density would be reduced if the availability of phosphorus was decreased, but whether that decrease actually takes place is not yet known.

Large aquatic plants also seem to be altered by acidification. In some acidified lakes, particularly those studied in Sweden, abnormal and very dense growths of sphagnum moss are found. In Lake Colden, where pH values declined from about 5.5 in the mid-1950s to 4.7 in the summer of 1979, sphagnum, not reported in a botanical survey conducted in the 1930s, is now abundant on the lake bottom. Another development seen in the Swedish lakes, Lake Colden, and many other acidified lakes, is the extensive growth of long, threadlike algae.

Both the sphagnum and the algae form mats that become a tight barrier, sealing off the bottom sediments from the overlying water. Since normal microbial decomposition seems to be retarded by acidification, the underside of these mats may constitute a rich source of organic materials. Low rates of microbial activity eventually consume all the oxygen in this zone, and a new oxygen-free environment develops. Anaerobic bacteria (those that live without oxygen) can thrive there, and although they are slower and less efficient in decomposing material than aerobic bacteria (those that require oxygen), they too decompose the dead plant matter, producing the gases carbon dioxide, methane, hydrogen sulfide, and some more complicated and smelly organic acids and sulfur compounds as their waste products. These wastes erupt from below the algal mat in great bubbles. I suspect that this is the cause of the garbage-dump-like odor that wafts over the surface of some acidified Adirondack lakes during the warmest parts of the year.

In summary, lakes and streams sensitive to acidification are located in regions where the bedrock and overlying soils are deficient in easily weathered minerals and thus cannot provide much buffering capacity to surface waters. Mountainous regions are particularly susceptible to acidification. Many lakes and streams in North America from Florida to Newfoundland have already been acidified. In extreme cases, the biological consequences include the complete elimination of fish and many other species of animals and plants. At intermediate pH levels, the relationships among organisms are likely to be changed in ways that are not yet known but that may exacerbate the problems of freshwater fish life. ☐

Plant litter in lakes, such as these autumn leaves, is an important source of food for animal life. If the microbial activity that makes this food available to animals is inhibited by acidification, the lake's entire food web may be affected.

Bruce D. Thomas

Clyde H. Smith

Lake Colden in the Adirondacks, once highly prized by trout fisherman, is now so acidic that fish cannot survive in its waters.

lakes at elevations above 2,000 feet. Fifty-one percent of these lakes were found to be acidified to a pH of 5 or less, and 90 percent of those found acidified had no fish. Some of those lakes supported fish forty years ago. Studies made in the 1970s in Canada also show that lakes in certain areas, ranging from southwest Ontario eastward to Nova Scotia, are losing all their species of fish.

Levels of pH and alkalinity taken from the 1930s through the 1950s are now considered unreliable because the methods then used for analysis put chemicals into the water to produce a color indicator of acidity and alkalinity, and that process altered the variables being measured. Electronic methods of measurement have replaced the old techniques, but the unreliability of the old data has caused some people to question whether or not acidification has occurred at all. They suggest that perhaps the lakes were always acidified. The biological data, however, are an independent and reliable indicator of acidification. Fish have disappeared from numerous lakes and streams that are reported, on the basis of measured chemical change, to have become acidified. Fish have also disappeared from hundreds of bodies of waters for which no chemical data from an earlier period are available. These waters are now too acidic and their aluminum concentrations too high for fish to survive. When fish are stocked in such lakes, they die. It's hard to argue with a dead fish.

The futility of stocking such waters is illustrated by the history of Lake Colden, a small lake at an elevation of almost 3,000 feet in the heart of the Adirondack Mountains. Described as a fisherman's paradise, Colden was one of the best trout-fishing lakes in the area but the annual catch declined from the 1950s through the 1960s. Efforts to stock the lake in the 1960s met with failure; the new fish died quickly. The last fish disappeared in 1970.

The food supply available to fish in lakes is greatly altered as acidification proceeds. In those lakes having a pH from 5 to 6—a range in which the ionized hydrogen level has a marginally negative effect on trout—there are significant changes in the availability of different species of zooplankton (microscopic organisms suspended in the water), insects, other aquatic invertebrates, and plants, all of which serve as food for some fish. The number of zooplankton species declines with decreasing pH levels as was demonstrated in my work involving large-scale surveys of Norwegian lakes. Scientists at the University of Bergen, in Norway, evaluated the biomass, or weight, of bottom-dwelling invertebrates in three lakes with a pH range of 4.3 to 4.7 and five lakes with a range of 5.8 to 6.2 and found less food available to fish in the more acidic lakes. Although the availability of fish food organisms has been found to decrease in some acidified lakes, the effects of these changes on fish life have not been investigated.

Some of the invertebrates that are the normal elements of a fish diet have a low tolerance for acid and cannot be found below a pH level of 6. Such is the case with the tadpole

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THE ASSOCIATION
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PROTECTION OF THE ADIRONDACKS

July 7, 1981

Excerpt from the forthcoming annual
report of this Association:

THE CLEAN AIR CONTROVERSY

There is no lack of evidence that nitrates and sulphates have created acid conditions that, in some waters, have seriously impaired or extinguished nearly all forms of aquatic life either by direct action or by leaching toxic metals from adjoining soils and rocks. Fish, amphibians, crustaceans, insects and vegetation have all been affected as well as the most primitive cell life. Nevertheless, in the case of soils, the evidence is less apparent, especially as regards nitrates, which have some beneficial effects. Furthermore, the soils contain within themselves more buffering capacity than lakes and rivers. The granitic rock of the Adirondacks and eastern Canada, however, provide but little buffering capacity compared to areas with substantial calcium bearing sedimentary rock.

Yet industry and the utilities continue to maintain that not enough is known or established to justify the expense of appropriate scrubbers or other pollution control devices. The atmospheric science fraternity agree to the extent that much is not known about the phenomenon of acid precipitation. Simply put, the sulphur dioxide (SO_2) emitted from high stacks travels along considerable distances exposed to ozone and sunlight, is thereby transformed into SO_3 and then into sulphuric acid (H_2SO_4) on admixture with water molecules as water vapor rises and condenses. Some atmospheric scientists maintain that the higher the level of sulphur dioxide, the further the plume of pollution may have to travel before transformation and precipitation so that a curtailment of emissions may only become noticeable at the extremity of the plume, which the weather varies as to length and direction. Additionally, the relative contribution of ozone from automotive exhaust to the total acidic deposition phenomenon is uncertain. Such opinions provide the utility industry with a rationale to delay installation of pollution control devices -- scrubbers which are not only costly, but produce substantial quantities of wet or dry waste whose disposal constitutes a problem. Thus, both from a cost basis and an environmental basis, there exist powerful conflicting regional interests. For example, source-reception area analyses indicate that the Adirondacks receive three times as much sulphur deposition from Ohio as from intrastate sources, and Canada is believed to receive almost three times as much from the U. S. as the U. S. receives from Canada.

The issues involved require action by the Environmental Protection Agency, the State Department, and possibly the courts. At the moment, the struggle is centered around amending the law itself. Also central to any solution is the matter of the financial health of the electric utility industry. Lower imports of oil and a balanced budget should result in lower overall interest rates. Utility company interest rates could be further reduced through more generous increases in electricity rates by public service commissions and strict EPA enforcement of the Clean Air Act would act as a spur in this regard. The company savings in borrowed or equity capital costs would be substantial enough to provide for coal conversion, coal washing where appropriate, and a large measure of pollution control devices. Radioactive risks resulting from acts of terrorism or war may restrict the construction of additional atomic fission plants.

There exists pressure to amend the Clean Air Act as regards the strictness of emission requirements on new installations. Should such action be taken, much stricter emission standards on existing plants will be needed as they will be operative over a much longer period than initially contemplated. An inevitable time lag can be expected before federally sponsored research and enforcement procedures result in curtailment of acid precipitation. Because of the responsibility of the Federal Government in regard thereto, federal legislation should provide funds for the liming of impacted lakes to prevent the loss of additional waters and to encourage experimental reclamation.

……………………………

July 7, 1981

MEMORANDUM SUPPLEMENTING THAT SECTION OF THE ASSOCIATION'S ANNUAL REPORT DEALING WITH THE CLEAN AIR CONTROVERSY

The avowed purpose of the current republican policy of decentralization and deregulation is to return authority to the states, local government and business. The theory is that local judgment can best determine what is important, who can best be trusted as to wisdom, ability and honesty. Although now espoused by a republican president, democrats have been the champions of states' rights in years past.

Following these principles, oil prices are being decontrolled and we are apparently going to decontrol gas ahead of schedule. So be it. But, if we are to decontrol these fuels, we should also liberalize control of utility rates. Fuel adjustment clauses just encourage utilities to continue using an expensive fuel rather than convert to another as the latter involves capital expenses for new combustion equipment and, in the case of coal, probably pollution control equipment.

The best way to spur gas or coal conversion and pollution control is not through low cost loans but by enforcing the Clean Air Act and amending the Internal Revenue Code to allow for fast depreciation of the combustion equipment and faster depreciation of the requisite pollution control equipment. The public service commissions (or other rate setting state bodies) can then grant rate increases sufficient to finance these investments and to provide the utilities with a rate of return commensurate with the cost of their capital. Because of existing environment permitting uncertainties, there is little incentive for a utility whose securities sell in the market at levels well below book value to make any capital investments.

Most important is that enforcement of the Clean Air Act will put pressure on high emission states to become better neighbors to pollution reception areas.

In addition to the accelerated depreciation that the utilities enjoy (now five years), they also enjoy an investment tax credit of 10% with an additional 5% on energy producing equipment. It is possible that some pollution abatement installations could be funded on a tax exempt basis as has been done in some industrial cases, but the principle involves is, I believe, an inequitable handout similar to a low cost loan from the government or a government guaranteed loan. In fact, there was so much criticism of this practice that it may not be possible to issue tax exempt securities for this purpose anymore.

I am particularly impressed with the statement at the end of Dr. Oppenheimer's testimony before the Senate Committee on Environment and Public Works to the effect that the National Commission on Air Quality had estimated that a 7,000,000 ton or 40% eastern utility sulphur dioxide emission reduction could be achieved by 1990 with a source emissions limit of two pounds per million BTU funded by an average increase of less than 2% on eastern utility bills.

THE ASSEMBLY
STATE OF NEW YORK
ALBANY

STANLEY FINK
SPEAKER

September 24, 1981

The Honorable James H. Scheuer
Chairman
Subcommittee on Natural Resources,
Agriculture Research and Environment
U.S. House of Representatives
Rayburn House Office Building, Suite 2321
Washington, DC 20515

Dear Congressman Scheuer:

On September 18, 1981, I testified at the Subcommittee's public hearing on Acid Precipitation which was held in Lake Placid, New York. I would like to make a formal correction for the record in the statement that I presented to the Subcommittee.

My statement contained a quotation from Mr. David Stockman, Budget Director, and attributed it to a letter he had written to the Coalition of Adirondackers to Neutralize Acid Rain Inflow. In actuality, Mr. Stockman's statement was made in a speech to the National Association of Manufacturers in April 1980.

Of course, the precise text of the quotation attributed to Mr. Stockman is correct and its implications regarding the acid rain problem still stand. While Mr. Stockman's office has so far refused to comment on the quotation, it is clear that the Administration's proposals for amendment of the Clean Air Act indicate that they do not consider acid rain to be a serious environmental problem. The political philosophy articulated by Mr. Stockman in the April 1980 NAM speech embodies the policy which the Administration is now seeking to establish.

I urge you as Chairman of the Subcommittee on Natural Resources, Agriculture Research and Environment to continue your diligent work in protecting the environment. As I said at the hearing, I believe that there are reasonable, cost-effective technologies for reducing sulfur dioxide and nitrous oxide emissions from coal-burning power plants in the Ohio River Valley which will not dramatically drive up electricity costs.

I urge you to adopt this reasonable cost-effective approach rather than the reckless regulation elimination approach articulated by Mr. Stockman in his NAM speech.

Thank you for making this correction in the record. I hope it has not caused any inconvenience to the Subcommittee.

Sincerely,

Stanley Fink

SF/rtl

[From Science, March 1981, vol. 211, No. 4488]

THE FIGHT OVER CLEAN AIR BEGINS

THE OUTCOME OF A CLASH IN CONGRESS WILL AFFECT AUTOS, SYNFUELS, UTILITIES, AND THE STEEL INDUSTRY, TO LIST JUST A FEW

(By R. Jeffrey Smith)

Congress has begun to consider major changes to the national Clean Air Act, launching what promises to be the most significant environmental struggle of the year. On the table are amendments that will affect virtually every industrial decision in the nation involving production, expansion, and relocation.

Business and environmental groups each have long agendas for the discussion, to be taken up initially by the full Senate Committee on Environment and Public Works, chaired by Robert Stafford (R-Vt.), and the House Subcommittee on Health and the Environment, chaired by Henry Waxman (D-Calif.). Stafford says he expects that the act's reauthorization to require at least 5 months, although as long as 2 years might be necessary "if interest groups seek to change the fundamental character of the law."

Stafford believes the law requires "only refinement and fine tuning," a view apparently shared by other congressmen who will figure prominently in the debate. Representative John Dingell (D-Mich.) and Senator John Chafee (R-R.I.), for example, both say they favor changes that will reduce that act's complexity, while preserving its overall goals. But the clash of regional interests, heightened by increasing concern about industrial performance and energy production, could result in some extreme proposals. Waxman has already warned of "some proposals which in the name of 'fine tuning' would actually gut the Clean Air Act. These must be resisted."

While no business group has openly avowed such a goal, there is no doubt that most would like to see many of the provisions in the act loosened and some of them eliminated entirely. Groups such as the Business Roundtable (of the top 100 corporations), the Chemical Manufacturers Association, the National Coal Association, the Edison Electric Institute, the Motor Vehicle Manufacturers Association, and dozens of other trade groups have been mobilizing for some time.

These groups claim that the act stifles industrial growth, constrains productivity, and bars the development of new energy sources by banning either new construction in polluted areas or expansion in areas that already have clean air. A group of construction unions and oil and chemical firms has hired John Quarles, a former deputy administrator at the Environmental Protection Agency (EPA), to coordinate their lobbying effort. Quarles' agenda for reform includes the elimination of strict rules against air quality deterioration in areas considerably cleaner than the national goal, more flexible deadlines for attainment of the air quality goals, and the loosening of rules against new construction in areas where the goals have not been met.

On the other side of the issue, environmentalists have been organizing with equal vigor. Five national groups have combined to defend the act under the rubric of the Clean Air Coalition. One of the groups, the Natural Resources Defense Council (NRDC), has recently hired David Hawkins, who was EPA administrator for clean air during the Carter Administration to do some of its lobbying. Hawkins' agenda includes the preservation of most of the existing clean air requirements, the streamlining of EPA review for new construction permits, and the enactment of stricter controls on hazardous pollutants and chemical precursors of acid rain.

Congressional sources say that debate will ultimately center on the recommendations of the Reagan Administration, which are expected in late spring. The Administration has already drawn fire from environmentalists by proposing to limit a requirement that firms in highly polluted areas install expensive pollution control equipment. The change, announced on 9 March, is intended primarily to benefit the automotive and petroleum industries. Because the change involves only a reinterpretation of existing EPA rules, it is not subject to congressional approval.

Until more of the Administration's proposals are known, the major topic of discussion will be the recent report of the National Commission on Air Quality, which was established by Congress when it last revised the act in 1977. The commission, composed of four congressmen and nine others representing a broad spectrum of views, calls its recommendations a compromise between the environmental and industrial extremes.

The commission's thick report, released on 2 March, states that the act has been responsible for a significant reduction in the overall level of air pollution, noting in particular reduced concentrations of carbon monoxide, sulfur dioxide, and suspended particulates—pollutants that can cause or aggravate a variety of respiratory diseases. The act sets air quality goals for these and four other pollutants (ozone, hydrocarbons, lead, and oxides of nitrogen) and requires the states to develop and implement a plan for meeting the goals by 1982, or in the case of ozone and carbon monoxide, by 1987. Under the current law if a state fails to meet the deadlines, all new construction in the area of noncompliance can be barred, and certain federal funds withheld.

The commission says that while most regions appear to be on track in meeting the deadline, eight cities will miss the the 1987 mark. Ozone in Los Angeles, for example, is "intractable and no reasonable level of effort is likely to result in attainment," the commission report says. To avoid unjustly penalizing these areas as well as any others that cannot comply in time, the commission recommends eliminating the deadlines and potential sanctions, which, in any event, had little effect in prodding the states to work harder. The commission suggests only that new companies in these areas should be obligated to install pollution control devices roughly comparable to the best available anywhere, a standard to be revised at 3-year intervals. Eventually, as the technology improves, the aggregate pollution within the areas will reach the national goal.

Three of the commission members disagreed with this conclusion. One of them is Richard Ayres, an attorney with NRDC, who says that "without deadlines, the determination of what controls are reasonably available would slip inevitably toward justifying status quo controls, legitimizing a failure to do more, and achieving no progress toward healthful air. . . . Without a [deadline], there will be nothing concrete to limit the weight given the industries' concerns in determining what is reasonable." Industry claims, on the other hand, that elimination of the deadlines and penalties is the only way to avoid stifling economic growth in regions that simply require more time to improve the air quality.

Another disputed commission recommendation is that Congress should eliminate some of the regulations covering air quality in regions that already meet the national goals. The act now says that, in the vicinity of national parks and wilderness areas where the air is relatively pristine, pollution can increase by only a small percent. In other areas where the air is not pristine but still relatively clean, pollution levels can increase as much as 35 percent (as long as the total pollution is still less than the overall goal). New industries in these areas must install pollution controls roughly comparable to the best available anywhere. In addition, the firms must prove, by monitoring the air for at least a year at a cost of as much as $1 million, that their plants will comply with the overall limit.

Many critics, including some in the environmental movement, say these requirements are awkward or unworkable in practice. A recent report by the National Research Council says the states have been applying the preconstruction monitoring rules too rigidly, and that the 35 percent limit should be regarded only as a benchmark, not an absolute ceiling. But a majority of the air quality commission recommended dropping the limit, and sharply reducing the amount of land that might be included under the most stringent controls. Pollution levels even without these limits will not worsen over the next 10 years and possibly beyond, the commission claims. Ayres disagrees, arguing that the requirement for up-to-date pollution control equipment is by itself inadequate "to keep clean air clean." Except for parks and wilderness areas, he says, clean air regions in 90 percent of the country "could be dirtied to levels no better than many of our major cities."

Additional controversy may be generated by the report's recommendation that Congress set a timetable for the regulation of particularly hazardous pollutants, a recommendation that industry opposes and environmentalists favor. To date, EPA has set emission standards for only three such pollutants, though it has listed about 40 more as potentially hazardous. The commission concluded that EPA has been reluctant to set such standards largely because the costs of compliance are so high.

Although EPA has ignored some previous congressional deadlines, the commission believes it may be worth trying again.

In two victories for environmentalists, the commission recommended that air quality goals continue to be set without regard to the economic costs of compliance, and that Congress order a significant reduction in emissions of sulfur dioxide by 1990. The Business Roundtable and other industrial groups had suggested that costs and benefits be compared in a determination of the air quality targets, and also that additional study be made of the impact of acid rain before additional regulation of sulfur dioxide is required.

Much of the debate will center on the wisdom of transferring additional authority to the states under the Clean Air Act. Business groups will argue that state and local agencies are better equipped to judge local enthusiasm for varying degrees of air pollution control. Environmentalists will argue that the states have done a poor job of enforcing the law since 1977, have rarely required the most stringent or up-to-date pollution controls, and have virtually ignored the impact of pollution on agriculture, wildlife, and building deterioration.

Senator Stafford tentatively plans to take his committee on the road for hearings in Maine on acid rain, in Colorado or Wyoming on synthetic fuels, in Detroit on automobiles, in Pittsburgh on the steel industry, and in California for an investigation of requirements that new air pollution in dirty areas be more than offset by reductions in existing emission sources.

CLEAN AIR AT OMB . . .

Under a general program of regulatory reform announced in February, the Office of Management and Budget (OMB) is to have general oversight of environmental regulation in the Reagan Administration. That places OMB director David Stockman in a good position to influence any proposals to amend the Clean Air Act. Stockman, a former member of Congress, served on the National Commission on Air Quality from 1978 to 1980.

Stockman's views of the act, and of the commission, are generally scathing. In a speech to the National Association of Manufacturers in April 1980 he said: "As many of you know, the National Commission [on Air Quality] consists largely of a choir of the faithful committed to issuing melodious harmonies to the tenets of orthodoxy regarding the Clean Air Act, and I'm somewhat of a self-avowed heretic in that regard so it's difficult for me to talk about it. . . .

"As I got into it and began to note anomalies . . . I came to the conclusion that the Clean Air Act, like the Ptolemaic model of the solar system that began to develop more and more elaborations and exceptions and complications as the basic model proved to be wrong . . . has become increasingly unplugged from reality and that we are probably at a point today where the whole thing has gone off the deep end in terms of sheer bureaucratic fiction and in terms of what I would call institutionalized obscurantism. . . .

"In my view almost every one of those ambient standards are far too stringent relative to what both economic and public policy and the medical evidence would suggest. Clearly we know that in the case of ozone. There simply isn't any credible evidence to put the standard at 12 parts per billion. It could be substantially higher than that, but if it were, we would find, lo and behold, that 95 percent of the country is already in compliance and that you wouldn't need this witch hunt against hydrocarbon emission from paint shops and lawn mowers and so forth. . . .

"I don't know how closely any of you follow the national papers, but if you read the Star, the Post, and The New York Times you find that somebody's orchestrating a pretty careful strategy, because every other day there's a new article about the acid rain problem. And it's written by reporters who know not a damned thing, and you'll excuse my language, about pollution, the techniques of pollution, the chemistry of pollution. And they're writing such preposterous and absurd things that what it's doing is creating an intellectual climate, an attitudinal climate, that will probably cause EPA or the Congress to lurch forward into an acid rain program that's based on nothing more substantial than the tail pipe standards were in 1970.

"I kept reading these stories that there are 170 lakes dead in New York that will no longer carry any fish or aquatic life. And it occurred to me to ask the question . . . well how much are the fish worth in these 170 lakes that account for 4 percent of the lake area of New York? And does it make sense to spend billions of dollars controlling emissions from sources in Ohio and elsewhere if you're talking about a very marginal volume of dollar value, either in recreational terms or in commercial terms?"

Stockman went on to endorse relaxation of the air quality standard for sulfur dioxides. The moderator for the manufacturer's group commented afterward that it was "encouraging to know that somebody who thinks like that is still in Washington and has something to say."—R.J.S.

[From the National Geographic, November 1981]

ACID RAIN—HOW GREAT A MENACE?

(By Anne La Bastille)

Evenings, I often stroll out on my cabin dock to enjoy the view of an Adirondack lake. But the scene is not as I remember it. No trout rise to the water's surface, swirling sunset colors. No ospreys quest along the shoreline, scanning for fish. No otters sprawl on my rocky point, crunching bullheads for dinner.

North and south of where I live are at least 180 fishless ponds, about 6 percent of all the ponds and lakes in the Adirondack Mountains of New York.

Four thousand miles away I recently overlooked a silent lake in Sweden. Gnarled pines framed its sparkling, too blue waters. Dr. William Dickson, an aquatic chemist with the Swedish National Environment Protection Board, pointed to an ancient rock wall skirting the steep shore.

"The Vikings built this defense line a thousand years ago," he said, "and survived a long siege here. They had wood, water, and all the trout they could eat. But now, for the first time since the Ice Age, Stone Lake doesn't hold a single trout. I estimate that 20,000 lakes of the 100,000 in our country are fishless or about to become so."

It wasn't always this way. Earlier in this century Adirondack lakes and those of Scandinavia produced prime trout, and wildlife was plentiful. Then, as if a curtain were drawing slowly across a stage, aquatic organisms began to die in some of them, and other animals dependent on them declined.

Why? An energy-related problem called acid rain (or, more correctly, acid deposition, which encompasses dry as well as wet acidic substances). How great this menance is, no one is certain. But it now engages the efforts of hundreds of scientists from a range of disciplines, and a broad-brush picture of the problem is emerging.

Certainly, acid rain is affecting surface waters in the eastern United States, Canada, and Scandinavia. *Probably* it is affecting surface waters elsewhere, across wide areas of the Northern Hemisphere, and also corroding buildings; it *may* be threatening forests and croplands, the soils and groundwater that support them, even human health itself.

Despite these many qualifiers, the fact is irrefutable that fish in sensitive lakes are being destroyed by acid rain (as measured on a pH scale of 0 to 14). Thus the feisty brook trout of troubled Adirondack waters plays the role of the proverbial canary in the coal mine, warning us of impending peril.

CULPRIT: BREATH OF THE MACHINE AGE

The problem of acid deposition starts, most experts agree, with the worldwide burning of coal, oil, and natural gas. Despite general adherence to existing environmental controls, the smokestacks of electrical generating plants, industrial boilers, and smelters release sulfur dioxide and nitrogen oxides, the chief precursors of acid rain. Nitrogen oxides also puff from the exhaust pipes of motor vehicles and slowly escape from chemical fertilizers.

Other contaminants also are discharged; of particular concern are acidic soots and specks of toxic metals such as lead and cadmium. But it is the oxides of sulfur and nitrogen that are the major culprits in forming acid deposition, both wet and dry.

Some of these pollutants hover above the city or industrial plant that spawned them, creating clouds that sometimes settle on the local landscape. Moistened by dew or a local shower, these emission may transform into acids and damage vegetation and wildlife, etch car finishes, and corrode buildings and bridges. This short-range fallout leaves the blight and tarnish that we associate with the smoky cities of an earlier industrial era.

HIGH-FLYING POLLUTION AIDS ACID RAIN

More sulfur dioxide (SO_2) and nitrogen oxides (NO_x), along with other combustion products, climb skyward, especially when vented upward by tall stacks. There they circulate with the great air masses that form our weather systems. It is these venturesome travelers that become the chief contributors to acid precipitation.

Their flights may last for days and take them hundreds, even thousands of miles. En route, the pollutant molecules interact chemically with sunlight, moisture, oxidants, and catalysts to change into other compounds of sulfur and nitrogen. Eventually some of the compounds are captured within clouds or by raindrops and snowflakes to form acid rain and snow—which in reality are dilute solutions of nitric and sulfuric acids.

The remaining sulfur and nitrogen compounds sift down as gases and dry particles, awaiting the first rainstorm or dewfall to transform them into droplets of acid.

Because of these long journeys, acid deposition is no respecter of state nor national boundaries. Dr. Anthony Knap of the Bermuda Biological Station for Research has reported acid rain on that mid-ocean, non-industrial island, as has Dr. John M. Miller of the National Oceanic and Atmospheric Administration (NOAA) atop Mauna Loa volcano in Hawaii.

Perplexingly, certain sites in the less industrialized Southern Hemisphere receive rains as acidic as those of Hawaii and Bermuda. This suggests that the sulfur compounds are also released by biologic activity occuring in the oceans or that they are carried long distances.

Despite the insidious ease with which acid rain precursors can travel, regions where its impacts are noticeable are, as yet, relatively few and predictable. They lie mainly in the industrialized belt of the Northern Hemisphere, downwind from dense concentrations of power plants, smelters, and urban sprawls. Often they are mountainious, and as such they frequently bathe in rains and snows. Well watered, these areas are typically clothed in forests and laced with lakes and streams. Their soils aften are thin—a fragile flesh spread over a skeleton of glaciated bedrock.

This describes the Adirondack Mountains almost perfectly. It also fits other acid rain hot spots, such as rock-ribbed Nova Scotia, where nine acidified rivers no longer support salmon reproduction, and the Canadian shield country of southern Ontario and Quebec.

Other vulnerable areas include the Great Smokey Mountains, hundreds of sensitive lakes in Wisconsin and Minnesota, the Pacific Northwest, the Colorado Rockies, and the Pine Barrens of New Jersey. A striking parallel to New York's Adirondacks exists in Scandinavia, where galaxies of lakes glint among low mountains watered by acid precipitation drifting northward from Europe's industrial belt.

Conversely, certain areas can tolerate acid fallout because of the neutralizing effect of their alkaline soils—a natural resistance known as buffering. Limestone regions such as the Allegheny Mountains enjoy this immunity. A similar buffering takes place in much of the Midwest, where alkaline dust blown from the West can also neutralize acid rain before it falls to the ground.

NATURE FAR OUTDONE BY MAN

How long have we had acidic rain? Probably since the first rains fell on a newformed planet. Volcanic eruptions, forest fires, and even the slow bacterial decomposition of organic matter produce sulfur or nitrogen compounds. Lightning bolts form NO_x from the nitrogen in earth's atmosphere.

When administered in nature's measured doses, this atmospheric "pollution" can serve as a wholesome, gentle way of fertilizing the landscape. In good faith could Shakespeare extol the "gentle rain from heaven" in the Merchant of Venice, and Robert Frost write of downy flakes in this "Stopping by Woods on a Snowy Evening."

But this natural cycle began to give way about two centuries ago, when man intruded with the cloud of coal smoke that signaled the start of the industrial revolution. Suddenly, sulfur and nitrogen that had accumulated in fossil fuels for millions of years were released as rapidly as coal could be burned. Swiftly the volume of man-made pollutants gained on nature's. Today, a large coal-fired power plant can emit in a single year as much sulfur dioxide as was blown out by the May 18, 1980, eruption of Mount St. Helens in Washington State—some 400,000 tons.

The total amounts of SO_2 and NO_x that mankind releases are staggering. In 1980 the U.S. ejected more than 26 million tons of sulfur dioxide into the air in addition to nearly 22 million tons of nitrogen oxides. For Canada the figures were five million and two million tons. Last year the two nations, along with Europe, pumped almost 100 million tons of SO_2 into the atmosphere.

As early as 1852 an observant English chemist, Robert Angus Smith, discovered a relationship between the increasingly sooty skies of industrial Manchester and the acidity he found in precipitation. Twenty years later he used the term acid rain in a 600-page book on the subject.

This remarkable work was neglected until Dr. Eville Gorham, a Canadian ecologist now at the University of Minnesota, elaborated on Smith's work in the late 1950s. He too was initially ignored.

SCIENTIFIC INTEREST PIQUED BY SWEDE

Acid rain's deserved notoriety finally came in 1967 when a Swedish soil scientist named Svante Odén reported a pattern of increasingly acid precipitation over time and geographic area. From his studies he prophesized serious impacts on soils, waters, forests, and structures.

Employing colorful language that characterized acid rain as "chemical war," Dr. Odén provoked a fallout of concern that sparked the intense interest found among today's scientists. His findings established him as the father of acid rain research. In all fairness, however, Dr. Gorham must be considered the grandfather and Robert Angus Smith the great-grandfather.

Acid precipitation in North America found an early student in Dr. Gene Likens, an ecology professor at Cornell University. In 1963 Dr. Likens and Dr. F. Herbert Bormann of Yale had begun a multidisciplinary study of forest productivity in a small watershed of the Hubbard Brook Experimental Forest in New Hampshire. Their initial precipitation records revealed surprisingly strong acid content, considering the remoteness of the site.

The Hubbard Brook study provides the longest continuous record of acid precipitation chemistry in North America—a record that accurately shows annual fluctuations in acidity but no clear trend as to worsening or improving conditions through 1981.

TROUBLE FROM TALL STACKS

Until a few decades ago, air pollution was largely an urban concern. The economic surge that began with World War II brought increasing use of fossil fuels, and a corresponding increase in pollutants.

Well-intended regulations may unwittingly have aggravated the problem. New Environmental Protection Agency (EPA) rules in 1970 caused plants to increase the height of their stacks; thus winds carried pollutants far from local sources. Today in the U.S., 179 stacks tower 500 feet high or more, including 20 that reach 1,000 feet.

The record stack, a 1,250-foot giant at a nickel smelter in Sudbury, Ontario (right), also holds the record as the free world's single greatest source of SO_2 pollution—2,500 tons a day (albieit a welcome reduction from 7,000 tons daily in earlier years). Such huge stacks, spewing contaminants into large weather systems, have helped make air pollution an international phenomenon.

Nevertheless, experts acknowledge that much remains to be learned about acid rain, even such basic questions as: Where, exactly, are the specific sources of acid-causing pollutants? The answer is disputed, for its could involve the expenditure of large sums of money, and possibly even redirect the nation's energy policy.

"One of the major issues," explains Dr. Fred Lipfert, a scientist at Brookhaven National Laboratory on Long Island, "is the mechanics by which air pollutants enter rain.

"It's natural to assume that the fossil fuelburning regions of the eastern United States are responsible for their own acid rain. But the Ohio River Valley is a huge industrial user of coal, and because it has prevailing winds that carry its emissions eastward, it may, under certain conditions, be more important than eastern industry to such sensitive areas as the Adirondacks.

"Also," Dr. Lipfert continued, "the EPA in the 1970s permitted widely varying emission amounts from pre-existing smokestacks, with the tigher standards being applied in the heavily populated East. Some Midwest sources were allowed to disperse as much as 200 pounds of SO_2 per ton of coal. Because new sources are now allowed only 15 pounds per ton, the older plants, remain the biggest contributors."

Not everyone believes the blame can be so handily pinpointed. Those who argue the point represent, in large measure, the nation's energy companies and power utilities.

Says John M. Wooten, environmental director for the giant Peabody Coal Company: "Nobody has yet approved a direct relationship between the level of sulfur emissions in the Midwest and the amount of acid rain that falls in the Northeastern U.S. and Canada. And until we have this proof, we should go slowly in order to develop the most prudent control scheme. Before being required to retrofit expensive scrubbers to reduce emissions, we want assurance they will do some good—say, that a 20 percent reduction in sulfur emissions in the Ohio River Valley will bring a 10 percent decrease in acid rain back East."

DETECTIVES OF DIRTY SKIES

How do you prove that a specific Ohio power plant is sending out the emissions that are killing trout in my Adirondack lake, hundreds of miles downwind? How do you trace a molecule of sulfur dioxide on its long journey through dark and turbulent clouds?

To track pollutants, scientists engage in aerobatics that do credit to the flying circuses of old. Ducking in and out of drifting pollution plumes from urban areas and power plants, they take air and water samples in attempts to identify and track the flow. Computer-generated models then predict the pollutants' trajectories.

One of the most valuable tools in this sleuthing is a growing nationwide network of 84 acid rain monitoring stations, set up in the late 1970s under the guiding hand of Dr. Ellis B. Cowling of the School of Forest Resources at North Carolina State University. A private organization known as the National Atmospheric Deposition Program (NADP), it analyzes samples of rain, snow, and dry fallout from 32 states. A companion survey, the Canadian Network for Sampling Precipitation (CANSAP), covers 55 locales in Canada.

These monitors reveal that virtually all the eastern U.S. and much of southeastern Canada are receiving highly acidic precipitation. Measured on the pH scale, where 7.0 equals a perfect balance between acidity and alkalinity (diagram, page 660), the rains range from 4.1 to 4.6—ten to thirty times as acid as uncontaminated rain. Specific storms have dumped pH 2.7 precipitation—as acid as vinegar—on Kane, Pennsylvania, and pH 1.5 precipitation—stronger than lemon juice—on Wheeling, West Virginia.

THREE LAKES, THREE RESULTS

I can visit, conveniently close to my cabin a lake acidification study (one of 20 separate research projects in the Adirondacks) that is taking five-million-dollar look at the chemistry of wild lakes as a result of acid deposition. Sponsored by the Electric Power Research Institute, a nonprofit research arm for 600 electrical utility companies, the study traces what happens to three lakes and their watersheds from the moment acid rain and snow hit the treetops to their final flow from the outlets.

"What we're finding," explained Dr. James N. Galloway, an environmental chemist from the University of Virginia, "is that each lake is personalized in its reaction to acid rain. For example, no one has caught any brook trout at Woods Lake, which has had a pH of 4.7, for years—this is too acid for fish. But brookies thrive at Sagamore—pH 5.8—and at Panther—pH 7.0. Yet all three lie at roughly the same elevation within 20 miles of one another and receive the same kind of acid deposition.

"Many factors control this reaction: size and shape of the watersheds, type of vegetation, bedrock, and soils, and the residence time of precipitation in the soil. Fishless Woods Lake, with its shallow soil and steep slopes, provides little residence time and thus little buffering of the acid rain."

An important breakthrough in acid rain research came in 1977 from Adirondack studies by Dr. Carl Schofield of Cornell. Investigating how acidity actually killed lake fish, he observed that aluminum compounds were collecting in the gills of fry. To combat the pollutant, the fry exuded a mucus in such amounts it finally strangled them. Acid precipitation, Dr. Schofield concluded, was leaching aluminum from surrounding soils—a process known as mobilization—and bearing it into the lake water. Today soil scientists recognize that acid rain mobilizes many toxic metals, including mercury and lead.

Acid rain and its companion heavy metals produce a long laundry list of suspected threats to the environment. These extend far beyond aquatic ecosystems, to forests, crops, soils, wildlife, groundwater, manmade materials, and perhaps human health.

Many of these ills beset Scandinavia, where I went to see them firsthand. Aquatic chemist Dr. Arne Henriksen guided me on an hour's hike around the rocky shores of Norway's Hovatn Lake. The surface stretched mercury smooth, ebony black to a stony mountain.

"It's 60 miles to the sea," gestured Dr. Henriksen, "and hundreds more miles to the nearest pollution sources. But watch." He took my pH meter, a small gauge resembling a battery tester, and dipped its probe into the water. It read 4.4. "That acidity has come from somewhere!" he exclaimed, looking southward toward industrial Europe.

FOR FISH, SPRING CAN BE DEADLY

Quietly we rowed to a lone cabin on a peninsula, on loan for use as a field station for a massive acid rain research program known by its initials, SNSF. It was launched in 1972 following the disappearance of fish in southern Norway. As I stepped inside the shadowy building, outlines of two enormous brown trout on the wall caught my eye. Both were longer than my forearm with fingers outstretched.

Dr. Henriksen said, "Those were caught in the early 1930s. Not a fish has been taken by any method from Hovatn since 1945."

He started a fire in the corner hearth and picked up a worn cabin journal. "Here it tells that the owners often tried restocking the lake, introducing thousands of fish, but none survived. By 1967 they suspected acid rain. Discouraged, they offered their cabin and lake to the research project."

Dr. Henriksen explained how the most severe fish kills occur in early spring. All winter, the pollutant load from storms accumulates in the snowpack as if in a great white sponge. When mild weather gives the sponge a "squeeze," acids concentrated on the surface of the snow are released with the first melt. Thus, the first meltwater can be five to ten times more acid than the remaining snowpack. This acid shock, acting in concert with mobilized aluminum, produces the drastic changes in water chemistry that destroy fish life.

With predaceous fish gone, aquatic insects can flourish, unless they to are sensitive to acidity. Acid-tolerant species, such as water boatmen, thrive. All other acquatic fauna decline in variety, as do the species of phytoplankton. A reduction in the sheer numbers of these tiny plants may allow light to penetrate farther through the water. That's why acid-impacted lakes are often described as being unnaturally clear or bluish.

Larger plant life too is affected. Water lilies decline, while the sphagnum mosses and filamentous algae grow prodigiously. These can form impenetrable mats, sealing off oxygen and retarding decay of lake-floor litter. Looking into the crystal water of a lake in Sweden, I saw leaves on the lake bottom that had not rotted in three years.

No acid lake therefore is really dead. Instead its population structure reverts to fewer species, radically altering the food web.

LAND SHOWS MIXED EFFECTS

Unlike these dramatic effects on aquatic life, the influence of acid rain on crops and forests is difficult to measure. No conclusive evidence of actual crop damage by acid rain has yet been shown. This could stem in part from the fact that sulfur and nitrogen, even when administered in the form of mild acids, serve as plant nutrients.

Laboratory tests, in which crops are grown in simulated acid rain conditions, produce a mixed bag of results. Some show a reduction in crop yield, others no effect, and yet others showed actual yield increases.

Yet many scientists fear that long-term exposure to acid rain inevitably must cause plant stress.

Is acid rain curtailing forest growth? The answer to this vital question too remains an ambiguous yes and no. It is complicated by the fact that forest systems are biologically more complex than croplands, and have a longer response time to acid stress.

"During six years of field experiments, growth of Scotch pine has actually been stimulated by acid rain, at least on poor soils. "I heard from Dr. Folke Andersson of the Swedish University of Agricultural Sciences. "This change may be explained by the fertilization effect of the nitrogen that comes with polluted rain."

But Dr. Andersson was quick to add: "This fertilization probably cannot compensate for the delay in decomposition of forest-floor litter caused by acid rain, and the accumulation of heavy metals in soils over long times spans. And, in fact, another extended study has shown decrease in growth rate on both poor and good soils.

"We need another 25 years," he said, "to determine if acid rain is seriously impairing tree growth, or causing other bad effects."

However, a West German study recently linked acid deposition with the death of trees' feeder roots and the subsequent decline in forest growth.

DOES WILDLIFE SUFFER TOO?

Uncertainty also surrounds the effects of acid rain on wildlife. Unquestionably it is harmful to amphibians such as salamanders, spring peepers, and frogs—creatures that lay their eggs in acidified ponds and meltwater pools.

Dr. Erik Nyholm of the University of Lund in Sweden, studying the breeding biology of small songbirds along lakes in Lapland, found fewer eggs, less hatching success, and soft or missing shell material.

He theorizes that the birds were poisoned by aluminum from feeding on contaminated insects. "The aluminum probably was leached from the soil by the acid snow and rain," he said. "High aluminum content found in the bone marrow of the birds counteracted calcium deposition, resulting indefective eggshells. Other birds, feeding deep in the forest or around buffered lakes, showed no such problems."

A few mammals also may be showing biological reaction to acid deposition. In Poland, a large group of roe deer living in a forest directly downwind from Krakow's steel mills demonstrates definite declines in antler size and trophy value during the past 25 years. Polish biologists believe that the deer's habitat has been contaminated by acid and heavy-metal deposition.

The reaction of soils to acid deposition understandably stirs wide concern, for these are critical ecosystems, supporting the plants and animals that give us food, fiber, and forest products. They represent our long-term bank account. Is acid rain starting to eat up the principal?

Naturally acidic soils, common to many regions of the U.S. possess little built-in buffering capacity (pages 666–7). Laboratory and field experiments with simulated acid rain show that acidifying soils may undergo a host of undesirable changes: increased leaching of trace elements such as aluminum and manganese, a slowdown of the organisms that break down forest-floor litter, and reduced nitrogen.

HOW DIM THE FUTURE?

These laboratory results leave many scientists with a haunting fear. If acid deposition continues unabated, vast tracts of sensitive soils may slowly decline in fertility until their productivity fails. When, or if, this might occur, no one can calculate, but its effects could be difficult to reverse.

And what of corrosion—the eating away of man-made materials by acids? Engineers have despaired for decades as airborne pollutants have attacked structures ranging from steel bridges to tombstones. The list of the wounded includes many famous names: the caryatids of the Acropolis, Egypt's temples at Karnak, the U.S. Capitol. Even that glorious copper lady—the Statue of Liberty—is under the onslaught of acid rain and corrosive gases and particles.

If acid rain, with its associated gases and metals, can be detrimental to animals and structures, what might it be doing to people? No immediate, direct health problems, such as getting "burned" by acid rain, have been observed or reported. Indirect effects have been noted, however, both from dry and wet acid deposition.

Dry airborne pollutants—usually sulfates—are largely associated with respiratory diseases—chronic bronchitis, asthma, and emphysema. Dr. Leonard Hamilton, a Brookhaven National Laboratoryepidemiologist, estimated in 1975 that "acid sulfates from fossil fuel . . . emissions are responsible for 7,500 to 120,000 deaths a year." Few other scientists believe there is enough solid evidence to support such high figures.

Another health effect relates to acidified groundwater in Schadinavia. In western Sweden I drove through rural provinces with Dr. Hans Hultberg of the Swedish Water and Air Pollution Research Institute (page 656). We bounced over rough roads in farmland where severe groundwater acidification has begun, along with contamination by metals leached from the soil.

"See that farm over there?" Dr. Hultberg pointed. "The babies had diarrhea off and on for months until we found that high copper content in the drinking water was the cause. Their well was acid. The water leaches copper from the plumbing lines."

A HAIR-TINTING EXPERIENCE

We passed a small cottage. "The lady's hair there was tinted green," exclaimed Dr. Hultberg. "Green as a birch in spring. She washed it in well water turned green by copper sulfate."

Later I found an echo of this problem in the western Adirondacks as I guided Dr. G. Wolfgang Fuhs, and environmental scientist with New York's Department of Health, to isolated springs, wells, and small municipal water supplies. Owners in the area had been complaining of corroding plumbing systems and suspicious-tasting tap water. Dr. Fuhs found several home systems and springs with elevated levels of lead and copper. For each family he had the same advice: Let faucets run a few minutes after nonuse overnight to lower metal concentrations before drinking or cooking.

TIME BOMBS FOR TOMORROW

Is it surprising, given this parcel of known and feared effects, that some scientists rank acid rain with toxic-chemical pollution and carbon dioxide buildup as the three worst "environmental time bombs?" They compare the connective evidence between fossil-fuel emissions and acid rain effects to that of cigarette smoking and lung cancer: Though in each case the cause-and-effect relationship is not proved, even doubters of acid rain must agree that the combustion of fossil fuels has increased in past decades, that lakes and streams do show a loss of life.

The dilemma of acid rain will ultimately be solved by politicians, economists, and the public, acting on the best information we scientists bring forth.

The principal tool we have to work with in this country is the Clean Air Act. This federal law, controlling adverse effects of air pollution on public health and welfare, requires that the emissions from fossil-fuel burning facilities and motor vehicles meet certain standards.

It does so essentially in two ways. One is through an EPA requirement making new pollution sources use the "best available" technology to control emissions.

The second approach relates to existing plants. Here, each state is expected to regulate itself. A result is that no state needs to heed another's standards. Thus the SO_2 emissions Ohio allows are nearly 30 times higher than permitted in Connecticut.

Robert F. Flacke, commissioner of New York State's Department of Environmental Conservation, says firmly, "The Clean Air Act is really one of the chief reasons for the increase in acid rain. Not only did its earlier policy bring about the long-range transport of air pollution via tall stacks, it also permits New York and other clean-plant states to be dirtied by states with looser air standards."

Not surprisingly, these biases pit state against state, with at least half a dozen of them initiating legal actions. Another state of litigation attacks EPA for allegedly failing to do its duty to provide protection under provisions of the Clean Air Act.

The act is up for reauthorizations in Congress now, and swarms of lobbyists seek both to strengthen and to weaken it. Meanwhile, Congress allocated 12 million dollars under the Acid Precipitation Act of 1980 to spend on research in 1981, with more being recommended for 1982. A federal-level interagency task force directed by NOAA's Dr. Chris Bernabo is studying acid rain with a view toward developing a national strategy, and extensive research goes on at universities, national laboratories, and within the electric-power industry.

But the Reagan Administration is making no rush to judgment. In the words of A. Alan Hill, chairman of the Council on Environmental Quality: "Out scientific community is still unclear as to . . . what control methods should be used. In our opinion, we just don't know enought yet to impose control measures at great cost to the American people with questionable results."

NATIONS FALL OUT OVER RAIN

On the international scene, too, acid precipitation emerges as a politically poisonous brew—one that embitters the valued friendship between the U.S. and Canada.

"We calculate that half the acid deposition striking Canada is imported from the U.S.," explained Dr. Hans Martin, Canada's coordinator for acid rain research. "Furthermore, it's falling on a million square miles of Ontario and Quebec that lack adequate buffering capacity. A million and a half lakes dot that region, and some are already giving way to acid deposition."

The meaning of this in terms of cold Canadian dollars came across in a statement by John Roberts, Canada's Minister of the Environment.

"Fifteen percent of our gross national product comes from forestry," he noted, "a higher percentage than the automobile industry contributes to the U.S. economy. Yet this resource is being threatened. The second largest industry in Canada is tourism. But how many tourists will want to spend their time at fishless lakes?

"Your country, the United States," he observed, "is dumping its garbage at the expense of our country."

U.S. spokesmen retort that American emission controls are more stringent than Canada's (although Canadian regulations are being rapidly tightened), and that Canadian pollution also drifts onto the United States (although not in nearly the volume that the U.S. exports to Canada).

Recognition of the problem let to the creation in 1980 of a massive binational program aimed at devising an agreement on transboundary air pollution.

EUROPEANS JOIN FORCES

An impressive team effort has arisen in Europe. In 1979, 31 of the 34 member governments in the UN's Economic Commission for Europe signed the Convention on Long-Range Transboundary Air Pollution. Though it does not enforce controls, it morally commits each nation to respect the environment of other countries.

Erik Lykke of Norway's Ministry of Environment told me, "I'm praying this convention will bring a cleaner landscape 10 to 15 years from now."

Few scientists are so optimistic. Many see the year 2000 as the earliest that emissions can be stabilized, and then slowly reduced. Experts at EPA, for example, predict that under current controls SO_2 in the United States will stay constant or increase modestly to 29 million tons per year by the end of the century. NO_x on the other hand, will near 28 million tons a year and possibily outstrip SO_2 as a contributor to acid fallout.

What can be done to lessen this impact, and how much will it cost? The most obvious step lies in conservation of energy—simply using less fuel. Another approach, more complicated and costly, is to apply new technology to reduce emissions—the object of intensive research by the EPA, universities, and utility groups.

The cost of cleaning up is high; equipping older U.S. plants with scrubbers would require an investment of billions of dollars, and even then might reduce emisions by only a third. These costs might be mitigated by positive side effects—the generating of useful by-product such as commercial sulfuric acid and road-fill material, and the creation of new jobs.

Meanwhile, hidden costs of acid rain may already be surpassing the expense of controlling it. Metal corrosion by SO_2 may cost each American at least seven dollars a year, and possibly many times that.

Proof that a solution exists comes from Japan. The government issued stringent sulfur oxide controls in 1968 and encouraged use of low-sulfur fuels and desulfurization, by 1975 emissions had plunged by 50 percent even as energy consumption doubled. Since then, even stricter limits have been set, and nearly 1,200 scrubbers installed, compared to about 200 in the United States.

Scientists in several countries are experimenting with so-called curative approaches to acid rain. These include the breeding of acid-tolerant fish and crops, liming lakes to reduce acidity, and coating valuable structures and artwork against corrosion. Yet such solutions are only short term.

WILL THE 21ST CENTURY BE SILENT?

What of the future? "It's only a matter of time before we are forcibly pressed to do something," says Norway's Dr. Lars Overrein, head of the Norwegian acid rain project. "Today's acid rain is just the beginning. We are already worried about heavy metals and organic pollutants that come with acid deposition."

When I stand looking out over my lake, what will I see and hear come the year 2000? Will peepers be trilling, fish jumping, trees leafing, deer drinking, baby birds chirping? Or will it be a silent spring?

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